NAVAL *Postgraduate* SCHOOL 1993

MONTEREY, CALIFORNIA

OVERVIEW

The School

The Naval Postgraduate School is an academic institution whose emphasis is on study and research programs relevant to the Navy's interests, as well as to the interests of other arms of the Department of Defense. The programs are designed to accommodate the unique requirements of the military.

The Campus

Located in Monterey, California, on the Pacific Ocean 120 miles south of San Francisco, the Naval Postgraduate School campus covers 627 acres of land. The site, which has been home to NPS since 1947, houses state-of-the-art laboratories, numerous academic buildings, a library, government housing and impressive recreational facilities.

The Students

Nearly 2,000 students attend the Naval Postgraduate School. The student body consists of officers from the five U.S. uniformed services, officers from approximately 25 allied countries and a small number of civilian employees. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background.

The Faculty

The faculty, the majority of whom are civilians, are drawn from a broad diversity of educational institutions and represent a prestigious collection of scholars. Faculty/student interaction is high. Every class is taught directly by a faculty member— over 99% of whom have a Ph.D.

The Degrees

The Naval Postgraduate School offers classes leading to advanced degrees in a variety of technical fields.

MASTER OF ARTS DEGREE: National Security Affairs

MASTER OF SCIENCE DEGREE: Aeronautical Engineering, Applied Mathematics, Astronautical Engineering, Computer Science, Electrical Engineering, Engineering Acoustics, Engineering Science, Information Systems, Management, Mathematics, Mechanical Engineering, Meteorology, Meteorology and Physical Oceanography, Oceanography, National Security Affairs, Operations Research, Physical Oceanography, Physics, Systems Technology, Systems Engineering, Telecommunications Systems Management.

ENGINEER DEGREE: Aeronautical Engineer, Aeronautical and Astronautical Engineer, Electrical Engineer, Mechanical Engineer.

DOCTOR OF PHILOSOPHY: Administrative Science, Aeronautical Engineering, Computer Science, Electrical and Computer Engineering, Engineering Acoustics, Mathematics, Mechanical Engineering, Meteorology, Operations Research, Physical Oceanography, Physics.

DOCTOR OF ENGINEERING: Aeronautical Engineering Electrical and Computer Engineering, Mechanical Engineering.

For more information on admissions, or for a catalog, contact:

Director of Admissions
Code 62, Naval Postgraduate School
Monterey, CA 93943-5000
Telephone: (408) 656-3093 / DSN 878-3093

NAVAL POSTGRADUATE SCHOOL CATALOG

ACADEMIC YEAR 1993

TABLE OF CONTENTS

Introduction 6

Letter from the Chief of Naval Operations 6
The School and Its Mission 7
Accreditation 7
Degrees Conferred 7-8
Facilities 9-10

School Structure and Organization 11

Graduate Education Review Board 11
Board of Advisors 11
Administration 12
Administrative Staff 12
Academic Departments and Groups 12-13
Curricular Offices 13
Curricula Summary 14-17
Faculty Organizations 17
Student Council 17

Admissions 18

Selection Procedures 18
Naval Officers 18
Other U.S. Military Officers 18
International Military Officers 18
Civilian Employees of U.S. Government 18-19
Academic Profile Codes 19-20

General Information 21

Course Codes 21
Grading 21
Quality Point Rating (QPR) 22
Academic Counseling 22
Course Registration and Credit 22-23
- Overload 23
- Repetition of Courses 23
- Medical Absence 23
- Credit by Examination 23

Validation 23
Transfer of Credits 23-24
Dual Degree Programs 24
Curricula Conducted At Other Universities 25

Curricular Offices and Programs 26

Administrative Sciences Programs 26
Aeronautical Engineering Programs 26-52
Air-Ocean Sciences Programs 53-60
Antisubmarine and Electronic Warfare Programs 61-70
Combat Systems Programs 78-82
Computer Technology Programs 83-91
Electronics and Communications Programs 92-94
Joint Command, Control and Communications (C3) and Space Systems Programs 95-106
National Security and Intelligence Programs 107-128
Naval Engineering Programs 129-134
Operations Analysis Programs 135-145

TABLE OF CONTENTS (continued)

Academic Departments and Course Descriptions 146

Administrative Sciences Department 146-162
Aeronautics and Astronautics Department 163-176
Antisubmarine Warfare Academic Group 177-178
Aviation Safety Programs 179-181
Command, Control and Communications (C3) Academic Group 182-184
Computer Science Department 185-195
Electrical and Computer Engineering Department 196-213
Electronic Warfare Academic Group 214
Engineering Acoustics Academic Committee 215
Mathematics Department 216-226
Mechanical Engineering Department 227-238
Meteorology Department 239-247
National Security Affairs Department 248-260
Oceanography Department 261-268
Operations Research Department 269-283
Physics Department 284-298
Space Systems Academic Group 299-300

Defense Resources Management Institute 301-304

Appendices 305

A. Distinguished Alumni 305
B. Awards for Graduates 306-309
C. Awards for Faculty 310

Index 311-316

Academic Calendar 317-318

Campus Map ..... Inside Back Cover

INTRODUCTION

Frank B. Kelso, II
Admiral, U.S. Navy
Chief of Naval Operations

CNO GRADUATE EDUCATION POLICY

"Leadership and learning are indispensable to each other."
-- President John F. Kennedy

Graduate education is both a noble idea, and an ongoing necessity that enhances the quality leadership essential for the United States Navy. I believe graduate education is one of the tools absolutely required for officers who will face growing complexities in technological, managerial and political/economic fields in the Navy. Even in this era of fiscal austerity and competing requirements placed upon our junior officers, investment in graduate education must be pursued as a priority.

The fully funded graduate education programs are intended for lieutenants and lieutenant commanders who have demonstrated superior professional performance and the intellectual capability to complete a rigorous academic program. These academic programs are designed to equip officers with enhanced intellectual and analytical capacity and make them more skillful warriors and specialists.

Graduates of the Naval Postgraduate School are applying the noble ideas they developed and learned on campus at Monterey throughout the Navy today. Because of our commitment to graduate education, today's naval officer corps is recognized as a leadership that sustains the finest Navy in the world with the power of knowledge, and the unique resilience to operate successfully in the harsh, unforgiving environments of advanced technology, politics and the ocean.

Frank B. Kelso, II
Admiral, U.S. Navy

THE SCHOOL

To meet its educational requirements, the Navy has developed a unique academic institution at the Naval Postgraduate School (NPS) through the use of specially tailored academic programs, a distinctive organization and an uncommon tie-in between academic disciplines and naval applications.

The student body consists of U.S. officers from all branches of military service and international officers from allied countries. Selection of officers for fully funded graduate education is based upon outstanding professional performance as an officer, promotion potential and a strong academic background. Students receive graduate degrees as a result of successful completion of study programs designed primarily to prepare them for future career assignments; however, degrees are awarded on the basis of the same academic standards that prevail at other accredited institutions.

NPS is an academic institution whose emphasis is on study and research programs that are relevant to the Navy's interests, as well as the interests of other arms of the Department of Defense (DoD). The programs are designed to accommodate the unique requirements of the military.

THE MISSION

The Naval Postgraduate School was established to serve the advanced educational needs of the Navy. The broad responsibility of the school is reflected in its stated mission:

> To provide advanced professional studies for military officers and defense officials from all services and other nations. Our focus is to increase the combat effectiveness of our Nation's armed services by providing quality education which supports the unique needs and interests of the Defense establishment and usually leads to fully accredited graduate degrees.

An expansion upon this mission which has been excerpted from SECNAV INSTRUCTION 1524, May 23, 1986:

> The Naval Postgraduate School exists for the sole purpose of increasing the combat effectiveness of the Navy and Marine Corps. It accomplishes this by providing post-baccalaureate degree and nondegree programs in a variety of subspecialty areas not available through other educational institutions. NPS also supports the Department of Navy through the continuing programs of naval and maritime research and through the maintenance of an expert faculty capable of working in, or as advisors to, operational commands, laboratories, systems commands, and headquarters activities of the Navy and Marine Corps.

To fulfill its mission, the Naval Postgraduate School strives to sustain excellence in the quality of its instructional programs, to be responsive to technological change and innovation in the Navy, and to prepare officers to introduce and utilize future technologies.

ACCREDITATION

The Naval Postgraduate School is accredited by the Accrediting Commission for Senior Colleges and Universities of the Western Association of Schools and Colleges. Engineering curricula accredited by the Accrediting Board for Engineering and Technology (ABET) are Aeronautical, Electrical and Mechanical. The Administrative Sciences Curricula are accredited by the National Association of Schools of Public Affairs and Administration.

DEGREES CONFERRED

Although the curricula are tailored to address Navy requirements, they are developed within the framework of classical academic degrees, meeting the highest academic standards. Each curriculum leads to a master's degree; however, additional study can lead to either an engineer's degree or the doctor's degree.

DEGREES

MASTER OF ARTS DEGREES
National Security Affairs

MASTER OF SCIENCE DEGREES
Aeronautical Engineering
Applied Mathematics
Astronautical Engineering
Computer Science
Electrical Engineering
Engineering Acoustics
Engineering Science
Information Systems
Management
Mathematics
Mechanical Engineering
Meteorology
Meteorology and Physical Oceanography
National Security Affairs
Operations Research
Physical Oceanography
Physics
Systems Technology
Systems Engineering
Telecommunications Systems Management

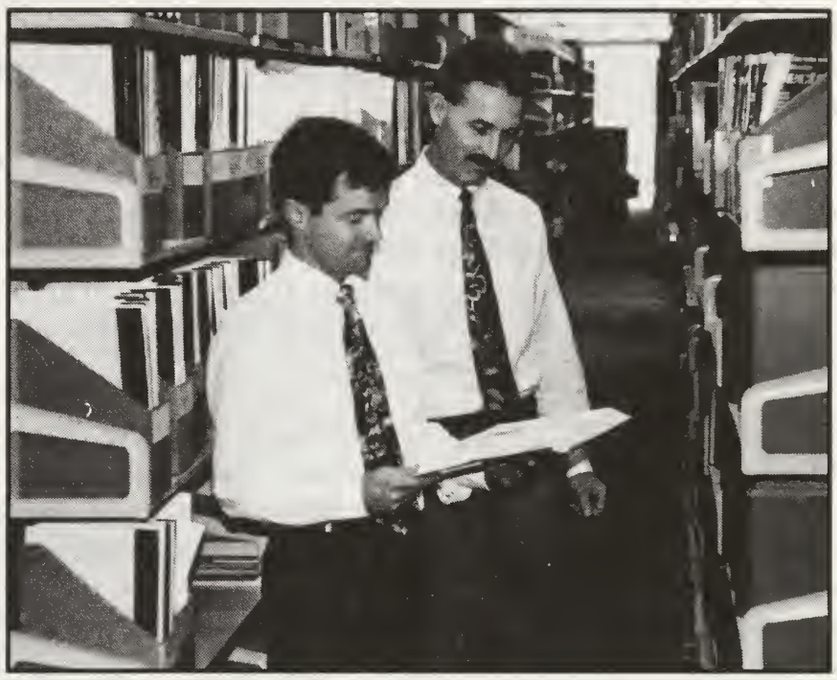
ENGINEER DEGREES
(Typically requires one year of study beyond the Master's Degree)
Aeronautical Engineer
Aeronautical and Astronautical Engineer
Electrical Engineer
Mechanical Engineer

DOCTOR'S DEGREES
Doctor of Philosophy:
Administrative Science
Aeronautical Engineering
Computer Science
Electrical and Computer Engineering
Engineering Acoustics
Mathematics
Mechanical Engineering
Meteorology
Operations Research
Physical Oceanography
Physics

Doctor of Engineering:
Aeronautical Engineering
Electrical and Computer Engineering
Mechanical Engineering

Dudley Knox Library

The Dudley Knox Library is a university library and as such is expected to meet standards established by the School's principal accrediting body, the Western Association of Schools and Colleges (WASC). It is, furthermore, unique within the community of academic libraries in that it is dedicated to supporting graduate-level education and research and also to providing for the special requirements of the Naval Postgraduate School. For example, in addition to its open-literature collections, characteristic of all university libraries, it administers one of the most powerful collections of classified (Secret/ Confidential) research reports in the United States. Presently, the library's holdings number over 475,000 bibliographic volumes in hard copy, 538,000 volumes in mircroform, and 1,500 journal subscriptions. The library has just completed an expansion project nearly doubling the usable square feet.



The Library organization encompasses five divisions: Administration, Acquisitions, Bibliographic Control, Reader Services, and Research Reports and Classified Materials. The Reader Services Division provides the open-literature sources such as books, journals, abstracting services and pamphlet materials. It affords access to online bibliographic databases in the curricular fields of interest by means of DIALOG and RLIN (Research Libraries Information Network), and it renders interlibrary loan services. The Research Reports and Classified Materials Division services the Library's classified and unclassified reports in hard copy and microfiche. It has access to the resources of DTIC (Defense Technical Information Center), and in addition it employs a locally developed system to generate customized and computer-based bibliographies of its holding in hard copy. This system also facilitates a current awareness service whereby patrons may be kept apprised of recently received reports in their respective fields of interest. Other services provided by the library include orientation tours for all new students, bibliographic instruction programmed to the needs of specific curricula, and personalized tours for new faculty members.

The Library Council is an advisory body with faculty members drawn from each academic department and academic group. Council members also serve as liaisons. In concert with their departmental colleagues, they advise on such matters as book procurement priorities and journal subscriptions.

The Library uses an online catalog through NOTIS, and future plans include automated circulation, acquisitions and serials control. The Library is also expanding its use of optically stored databases.

Campus Computing

The many computer-based and professional services of the Computer Center are available free to all faculty, staff and students of the School in connection with instructional, research or administrative activities. Round-the-clock operational support is provided on an IBM-compatible network, including an AMDAHL 5995-700A (dual processor) mainframe system loosely-coupled to an IBM 4381-Q13 computer. The larger system, the

AMDAHL, has 384MB processor storage, 1 Gigabytes of expanded storage for paging space and 40 I/O channels. Both systems share all the input/output equipment and auxiliary storage devices which include IBM3380 disks (models XE to XK), IBM 3480 Cartridge Tape Drives (18-track), IBM3420-8 Tape Drives (9-track, 6250bpi) and an IBM 3800-3 high-speed page printer. The most direct mode of user access is via 650 IBM 327X terminals, or PC-compatibles, distributed in public clusters and private offices throughout the academic buildings and attached by coaxial cable to the Center in Ingersoll Hall. In addition full micro-to-mainframe dial-up capability is supported at speeds up to 9600 bps. The mainframes are also accessible on the campus backbone communications network (presently supporting Ethernet on fiber and coax cable) which interconnects the great variety of building and departmental local-area networks and lab facilities. Wide-area network support includes Internet (at T1 speed), MILNET (56 kb/s) and BITNET/CREN. Among the facilities recently installed are an Automated Tape Cartridge Library for network mass storage and a Scientific Visualization Laboratory for high-end graphics and image processing, video recording and computer animation. Planned for 1993 are the installation of a high-performance computing system (most likely an entry-level supercomputer), an associated high-speed local network and powerful workstations distributed in the public areas.

The Center provides a wide range of software support under IBM's two mainframe operating systems: VM/XA (Virtual Machine/Extended Addressing), for interactive computing, and MVS/ESA (Multiple Virtual Systems) for batch-production and transaction processing for applications such as the Knox Library's on-line bibliographic retrieval system. The extensive programming facilities include FORTRAN, ADA, C, COBOL, PL/1, APL2, PASCAL and BASIC.

In addition, NPS operates six Learning Resource Centers - classrooms of networked PCs, Macintosh and UNIX workstations. These LRCs are used for scheduled classes and, at other times, for individual use. The professional staff conducts short courses, and provides consulting help in systems and applications programming, and on computer problem-solving tools and techniques. They also engage in a research and development program directed primarily toward continuously improving the campus computing environment and the exploitation of new and emerging technologies in support of academic computing.

Supplementing the Center's facilities are the many departmental classrooms and laboratories equipped with microcomputers and/or workstations which support their specialized educational or research needs. Most of these systems are on local-area networks which are connected, in turn, to the campus backbone.

The Management Information Systems (MIS) department provides direct support in all matters related to the administrative computing (i.e. computing facilities whose primary purpose is not instruction or research), and all matters related to the school's information resource management (IRM) program. The department also provides the school with technical advice on matters related to application system design, database management, networks and distributed systems, the introduction of new technology for administrative systems into the school, and the administration of the NPS LCM program.

The department operates a Banyan-VINES local area network (LAN) on campus. This network is comprised of seven file servers and offers a variety of software services to its users. Terminal emulation is provided for access to the W.R. Church Computer Center and to various Navy systems in Washington, D.C. Various Electronic-Mail (E-Mail) Gateways provide staff and faculty fast and easy access to military and academic correspondents across the nation and overseas.

SCHOOL STRUCTURE AND ORGANIZATION

The Naval Postgraduate School was established and is funded by the Congress of the United States. It is administered as an activity within the Department of the Navy. The institution's governance and administration follow norms for civilian higher education, adapted appropriately for the Navy's specialized needs.

GRADUATE EDUCATION REVIEW BOARD

A Graduate Education Review Board, chaired by the Chief of Naval Operations and including the Vice Chief of Naval Operations, the Deputy Chief of Naval Operations (Manpower, Personnel and Training, OP-01), the Superintendent, Naval Postgraduate School and a representative from the Naval Systems Command (on a rotating basis) meets annually to provide policy guidance and direction for the Navy's graduate education program. The Board reviews the adequacy and stability of resources and student input. Prior to this meeting, a separate Graduate Education Review Group, chaired by the Vice Chief of Naval Operations, meets to review graduate education issues and identify matters of potential interest to the Graduate Education Review Board. The Graduate Education Review Group membership includes the principal warfare sponsors, principal subspecialty primary consultants and the Superintendent, Naval Postgraduate School.

BOARD OF ADVISORS

The Board of Advisors is composed of distinguished professionals, consisting of highly qualified civilian educators, prominent citizens from business, the professions and other vocations, and active and retired military officers. The purpose of the Board is to assist the Superintendent on strategic matters of the Navy's Graduate Education Programs and advise the Secretary of the Navy of their needs. In fulfilling this objective, the Board assesses the effectiveness with which the Naval Postgraduate School is accomplishing its mission and evaluates its future plans. Board members are appointed for terms of two years by the Secretary of the Navy upon the recommendation of the Superintendent. Each appointment is renewable once for a second period of two years.

The Board meets annually at the Naval Postgraduate School and submits a report of its recommendations to the Secretary of the Navy via the Superintendent. Board members also serve on departmental academic review committees during the year and assist in other matters as requested by the Superintendent or the Secretary of the Navy.

ADMINISTRATION

The Superintendent of the Postgraduate School is a flag officer of the line of the Navy. His principal assistant is the Provost/Academic Dean, who is ranking member of the civilian faculty.

SUPERINTENDENT
Ralph W. West, Jr.
Rear Admiral, U.S. Navy

PROVOST & ACADEMIC DEAN
Harrison Shull, Ph.D.

The Superintendent has command responsibility for accomplishment of the school's mission. The Provost/Academic Dean is the chief educational officer and is responsible to the Superintendent for all academic matters. He is appointed by the Secretary of the Navy upon the recommendation of a council of NPS senior personnel, chaired by the Superintendent.

In addition to serving as the institution's president, the Superintendent is the academic coordinator for all graduate education programs in the Navy. He administers fully funded graduate educational programs at the Naval Postgraduate School, other service graduate schools and civilian universities.

ADMINISTRATIVE STAFF

Principal assistants to the Superintendent and Provost are two captains of the line and four civilian deans. The military positions are Dean of Students/Director of Programs and Director of Military Operations. The academic positions are Dean of Faculty and Graduate Studies, Dean of Research, Dean of Computer and Information Systems and Dean of Instruction. These positions are currently held by:

DEAN OF FACULTY AND GRADUATE STUDIES
Gordon E. Schacher,
Professor of Physics

DEAN OF STUDENTS/DIRECTOR OF PROGRAMS
Ross D. Parker
Captain, U.S. Navy

DIRECTOR OF MILITARY OPERATIONS
Joe Begbie,
Captain, U.S. Navy

DEAN OF COMPUTER & INFORMATION SERVICES
Barry A. Frew
Associate Professor of Adminstrative Sciences

DEAN OF RESEARCH
Paul Marto,
Distinguished Professor
of Mechanical Engineering

DEAN OF INSTRUCTION
Richard E. Elster
Professor of Administrative Sciences

ACADEMIC DEPARTMENTS AND GROUPS

Members of the faculty are organized into eleven Academic Departments and four interdisciplinary Academic Groups. Each is supervised by a chairman who reports to the Dean of Faculty and Graduate Studies. Over 80% of the teaching staff are civilians of varying professional rank and the remainder are military officers.

ACADEMIC DEPARTMENTS

- Administrative Sciences
- Aeronautics and Astronautics
- Computer Science
- Electrical and Computer Engineering
- Mathematics
- Mechanical Engineering
- Meteorology
- National Security Affairs
- Oceanography
- Operations Research
- Physics

ACADEMIC GROUPS

- Antisubmarine Warfare
- Command, Control and Communications
- Electronic Warfare
- Space Systems

CURRICULAR OFFICES

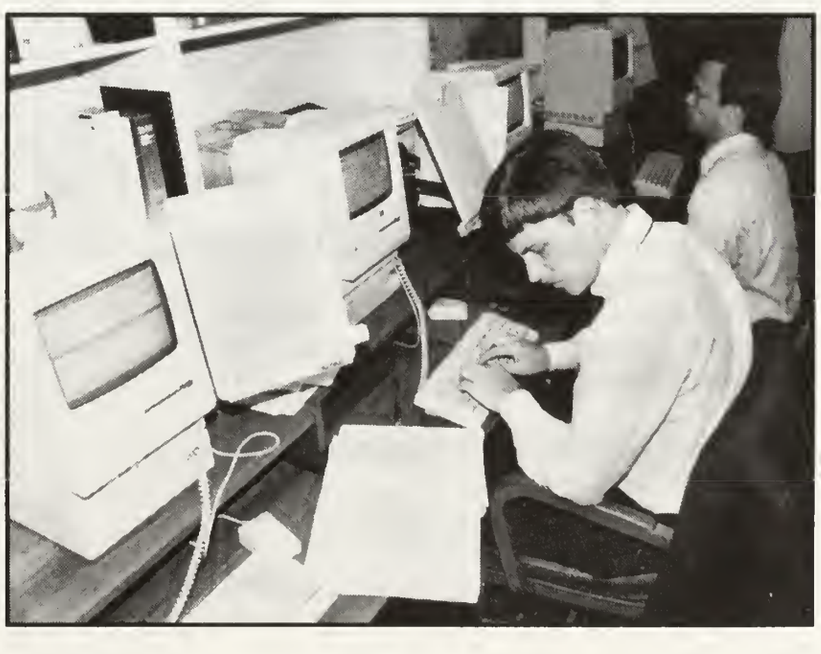
The Curricular Offices are organizational entities that are separate from, but interactive with, the Academic Departments in the educational operations of the school. The former are staffed by naval officers and civilian faculty members whose primary functions are threefold: (1) academic counseling and military supervision of officer students, (2) curriculum development and management to ensure attainment of professional and academic objectives, and (3) liaison with curricular sponsor representatives.

Students are grouped in accordance with their curricular programs and are assigned to one of eleven Curricular Offices for program supervision and for academic and professional counseling.

Students in each curricular group pursue similar or closely related curricula. Each Curricular Office is staffed by one or more military officers of suitable experience and rank and one or more Academic Associates. The latter are faculty members selected for this part-time assignment. They are responsible to the Deans for the integrity and academic soundness of the academic features of the Curricular Office operations. Curricular Officers ensure their curricula meet Navy needs and ensure the proper administrative operation of their respective offices. They report to the Director of Programs.

The following table summarizes the curricula offered through the Naval Postgraduate School. Specific academic requirements for enrollment are contained in each curriculum segment.

Students entering any of the technical curricula normally are ordered to a six-week mathematics refresher course. It begins in the seventh week of each quarter. This course is not designed to teach math, but rather to reacquaint students with calculus. During this refresher, students also take an introductory course in set and logic theory and a programming course in BASIC on desk-top microcomputers.



Some officers are ordered to Engineering Science (Curriculum 460) if they require more preparation for entering one of the technical curricula. This program is either one or two quarters long and includes calculus, physics and an introductory computer course.

NPS CURRICULA SUMMARY

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Administrative Sciences				
Transportation Logistics Management	813	18	July	36
Transportation Management	814	18	July	36
Acquisition & Contract Management	815	18	January, July	36
Systems Acquisition Management	816	21	January, July	36
Allied Officers, DoD Civilians, USA, USMC and USCG	817	18	January, July	36
Systems Inventory Management	819	18	July	36
Material Logistics Support Management	827	18	January, July	36
Financial Management	837	18	January, July	36
Manpower/Personnel Training Analysis	847	18	January, July	36
Aeronautical Engineering				
Aeronautical Engineering	610	24	April/ October	31
Aeronautical Engineering with Avionics	611	24	April/October	31
Air-Ocean Sciences				
Meteorology	372	24-36	Any Quarter	35
Air-Ocean Science	373	24-27	Any Quarter	35
Operational Oceanography	374	24	Any Quarter	35
Oceanography	440	24-36	Any Quarter	35
Hydrographic Science	441	24	October	35
Antisubmarine Warfare				
Antisubmarine Warfare	525	24	April/October	3A
Electronic Warfare	595	24	October	3A
Electronic Warfare International	596	24	October	3A
Combat Systems Sciences and Technology	533	27	April/October	33
Computer Technology				
Computer Science	368	24	April/October	37
Information Technology Management	370	24	April/October	37
Electronics & Communications				
Electronics Systems	590	21-27	Any Quarter	32
Joint Command, Control and Communications				
Command, Control and Communications	365	18	October	39
Space Systems Operations	366	24	October	39
Space Systems Engineering	591	27	January/July	39
National Security and Intelligence				
Middle East, Africa, South Asia	681	18	January/July	38
Far East, Southeast Asia Pacific	682	18	January/July	38

Curriculum	Curriculum Number	Normal Length (Months)	Normal Convening Dates	Cognizant Curricular Office Code
Western Hemisphere	683	18	January/July	38
Russia, Europe, Central Asia	684	18	January/July	38
Strategic Planning	688	24	January/July	38
Special Operations/ Low Intensity Conflict	699	18	July	38
Intelligence (S&T)	825(I)	18	April	38
Intelligence (Regional Studies)	825(II)	24	January/July	38
Intelligence (OPINTEL)	825(III)	12	July	38
Intelligence (OPINTEL)	835(IIIA)	15	July	38
Naval Engineering				
Naval Engineering	570	24-27	Any Quarter	34
Operations Analysis				
Operations Analysis	360	24	April/October	30
Operational Logistics	361	24	October	30
Advanced Science (Applied Math)	380	24	January/July	30

Each service identifies military billets that require specific graduate level education for successful performance. More than 6,000 subspecialty coded billets are presently identified in the Navy. Quotas for officer inputs to graduate education programs are generated annually to meet current and projected billet requirements. Sponsors such as the Naval Sea Systems Command and Naval Air Systems Command identify the skill requirements for subspecialty coded billets, and the Naval Postgraduate School administers curricular programs to meet the promulgated skill requirements. Curriculum titles, minimum threshold APC levels, subspecialty codes and degree titles are listed below by ascending curriculum number.

Curriculum Number	Curriculum Title	Admission APC	Subspecialty Code	Degree
360	Operations Analysis	324	XX42P	MS Operations Research
361	Operational Logistics	324	XX43P	MS Operations Research
365	Command, Control & Communications (C3)	325	XX45P	MS Systems Tech (C3)
366	Space Systems Operations	324	XX76P	MS Systems Tech (Space Sys. Ops)
368	Computer Science	325	XX91P	MS Computer Science
370	Information Technology Management	325	XX89P	MS Information Technology Management
372	Meteorology	323	XX48P	PhD Only for USN officers
373	Air-Ocean Sciences	323	XX47P	MS Meteorology & Physical Oceanography
374	Operational Oceanography	323	XX49P	MS Meteorology & Physical Oceanography
380	Advanced Science (Applied Mathematics)	205	XX41P	MS Applied Mathematics
440	Oceanography	323	XX49D	PhD Only for USN officers
441	Hydrographic Science	324	NONE	MS Hydrographic Sciences
525	Antisubmarine Warfare Systems	323	XX44P	MS Applied Science
533	Combat Systems Sciences & Technology	323	XX66P	MS Applied Physics
570	Naval/Mechanical Engineering	323	XX54P	MS Mechanical Engineering
590	Electronic Systems Engineering	323	XX55P	MS Electrical Engineering
591	Space Systems Engineering	323	XX77P	MS (Various)
595	Electronic Warfare Systems Engineering	325	XX46P	MS Systems Engineering
596	Electronic Warfare Systems for Allied Officers	325	NONE	MS Systems Engineering
600	Communications Engineering	323	XX81P	MS Electrical Engineering
610	Aeronautical Engineering	323	XX71P	MS Aeronautical Engineering
611	Aeronautical Engineering-Avionics	323	XX72P	MS AeronauticalEngineering
681	National Security Affairs (Middle East, Africa, South Asia)	355	XX21P	MA National Security Affairs
682	National Security Affairs (Far East, Southeast Asia, Pacific)	355	XX22P	MA National Security Affairs
683	National Security Affairs (Western Hemisphere)	355	XX23P	MA National Security Affairs
684	National Security Affairs (Russia, Europe, Central Asia)	355	XX24P	MA National Security Affairs
688	National Security Affairs (Strategic Planning)	335	XX28P	MA National Security Affairs
699	National Security Affairs (Special Operations/ Low Intensity Conflict)	355	XX29P	MA National Security Affairs
813	Transportation Logistics Management	345	1304P	MS Management
814	Transportation Management	345	XX35P	MS Management
815	Acquisitions & Contract Management	345	1306P	MS Management
816	Systems Acquisition Management	345	None	MS Management

Curriculum Number	Curriculum Title	Admission APC	Subspecialty Code	Degree
819	Systems Inventory Management	345	1302P	MS Management
825(I)	Intelligence(S&T)	334	XX17P	MS National Security Affairs
825(II)	Intelligence (Regional Studies	335	XX18P	MA National Security Affairs
825(III)	Intelligence (OPINTEL)	255	XX19P	MA National Security Affairs
827	Material Logistics Support Management	345	XX32P	MS Management
837	Financial Management	345	XX31P	MS Management
847	Manpower, Personnel & Training Analysis	345	XX33P	MS Management

FACULTY ORGANIZATIONS

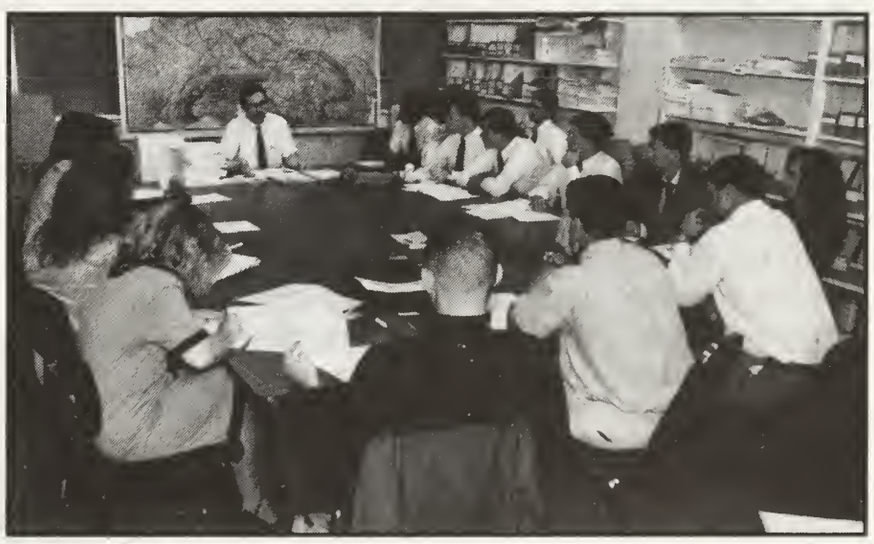
The faculty plays a role in school-wide policy making and planning through various established Councils. The Faculty Council functions as a primary faculty input advisory vehicle to the Provost and Superintendent. The Academic Council, a representative body of each academic department and group, has cognizance over all academic standards and degree-granting considerations. The composition of each Council and its specific functions are described in the NPS Organization and Regulations Manual.

STUDENT COUNCIL

The Officer Student Advisory Council (OSAC) is an organized communication mechanism between the NPS students and the NPS administration. It functions in an advisory capacity in matters involving curricula, facilities, procedures and policies deemed worthy of attention. The OSAC is comprised of thirty-five student representatives and membership is distributed among the curricula by student population, with each curriculum having at least one representative.

The OSAC is headed by a Chairman, Vice Chairman and Secretary elected by members of the Student Council. Officers serve for a six-month period.

Besides a Steering Committee and an Election Committee, Student Council committees are formed to correspond with those NPS committees or councils which have an impact or effect on the student body and which can give or receive benefit from such representation. OSAC representation is included in the following NPS standing Councils and Committees:



Academic Council
Faculty Council
Library Council
Exchange/Bookstore Committee

ADMISSIONS

U.S. Navy officers interested in attending one of the curricula offered at the Naval Postgraduate School are referred to OPNAVINST 1520.23 and to the latest OPNAVNOTE 1520. These documents provide guidance, information and policy for the Navy's fully funded graduate education program.

SELECTION PROCEDURES

NAVAL OFFICERS

Selection for the Navy fully funded graduate education program is based on outstanding professional performance, promotion potential and a strong academic background. Unrestricted Line officers being considered by statutory selection boards for promotion to Lieutenant or Lieutenant Commander are eligible for selection for fully funded graduate education. Restricted Line and Staff Corps eligibility information is available through community newsletters or directly from assignment officers. Boards will select groups of officers considered to be professionally qualified; upon determination of academic qualification (by NAVPSGCOL), individuals are eligible for assignment. Officers who are professionally qualified but lack academic qualifications should contact the Director of Admissions for information on ways to improve their academic background.

OTHER U.S. MILITARY OFFICERS

Officers on duty with other branches of service are eligible to attend the Postgraduate School. Requests for admission or transcripts from individual officers should not be sent directly to the Naval Postgraduate School. They should apply in accordance with the directives promulgated by the Department of the Army, Department of the Air Force, Commandant U.S. Marine Corps or the Commandant U.S. Coast Guard, as appropriate.

INTERNATIONAL MILITARY OFFICERS

Military officers from other countries may be admitted to most curricula. Their admission is subject to availability of quotas assigned to each country. The procedures for application are contained in OPNAV INSTRUCTION 4950.1E. Correspondence must be processed through normal channels; requests from individual officers should not be sent directly to the Naval Postgraduate School. In addition to fluency in English, candidates must satisfy the academic standards for each curriculum as described in this catalog.

CIVILIAN EMPLOYEES OF U.S. GOVERNMENT

A civilian employee of an agency of the United States Federal Government may be admitted for study upon request and sponsorship of the agency. Federal civilian employees are not required to pursue the curricula designed for officer-students as described in this catalog but instead determine, with the guidance of assigned academic counselors, the combination of courses that will best meet their needs.

A civilian who is expecting agency sponsorship should submit a written request for evaluation for admission at least six months prior to expected commencement of studies. A request should indicate the desired curriculum and degree intentions and be accompanied by a complete set of official transcripts of all previous college work. GRE and/or GMAT scores are not required but will be considered when included in the submission.

Requests for admission should be directed to the Director of Admissions, Code 62, Naval Postgraduate School, Monterey, CA 93943-5000. Questions about available programs or admission procedures may be telephoned to (408) 656-3093 or DSN 878-3093.

Any civilian employee of the United States Government is eligible to participate in the programs of the School. The individual's employing agency is expected to meet the tuition expense for regular on-campus enrollment.

Programs available to civilian students can be classified as follows:

Regular Curricula: The school's programs for officers are designed to meet the requirements of the services for specific education. The contents usually exceed the requirements for a graduate degree since the service's requirements, rather than degree requirements, determine the scope of each program. Civilian students may enter any curriculum at the point at which they are qualified and complete the curriculum along with regular officer students. The Programs section describes the available curricula.

Degree Programs: For civilian students, programs may be designed which lead to the award of a graduate degree while meeting the educational goals of each individual. In order to minimize the residency requirement, an off-campus preparatory program may be developed in consultation with a school advisor. If the available time in residence, typically four calendar quarters, is insufficient to complete degree requirements, the thesis-project portion of the program may be completed off-campus.

Non-Degree Programs: Civilian employees may desire to pursue a program for professional advancement without a degree objective. For groups of employees from an agency, special courses can be offered to meet particular requirements, provided the demand is in an area of expertise of the school.

Admission: For admission to either a degree or a non-degree program, the minimum qualification is an accredited baccalaureate degree with appropriate preparation for the proposed program. The school will require submission of official transcripts covering all college work completed to date.

CATALOGS

The point of contact for requests for Naval Postgraduate School Catalogs and admission to resident study programs is:

Director of Admissions
Code 62, Naval Postgraduate School,
Monterey, CA 93943-5000
Telephone (408) 656-3093 / DSN 878-3093

ACADEMIC PROFILE CODES

The Academic Profile Code (APC) is a three-digit code which summarizes pertinent portions of an officer's prior college performance. The Naval Postgraduate School routinely generates APCs for officers of most Navy communities, usually within three years of commissioning. The three independent digits reflect an individual's cumulative grade-point average (QPR), exposure to and performance in calculus-related mathematics courses and exposure to and performance in selected science/engineering areas.

First Digit

The first digit indicates overall academic performance and is derived from the following table:

Code	QPR Range
0	3.60-4.00
1	3.20-3.59
2	2.60-3.19
3	2.20-2.59
4	1.90-2.19
5	0 -1.89

(Failures and repeated courses are included in the QPR calculation.)

Second Digit
The second digit represents mathematical background according to the following criterion:

Code	Meaning
0	Significant post-calculus math with B or better average
1	Calculus sequence completed with B+ or better average
2	Calculus sequence completed with average between C+ and B
3	One calculus course with C or better
4	Two or more pre-calculus courses with B or better average
5	One pre-calculus with C or better grade
6	No college level calculus or pre-calculus math with a grade of C or better

Third Digit
The third digit represents previous course coverage in science and technical fields.

Code	Meaning
0	Significant pertinent upper-division technical courses with B+ or better average (Math Major/ Strong Math Minor)
1	Significant pertinent upper-division technical courses average between C+ and B
2	Complete calculus-based physics sequence with B+ or better average
3	Complete calculus-based physics sequence with average between C+ and B
4	One calculus-based physics course with C or better grade
5	No pertinent technical courses

A first digit code of 0, 1, 2, or 3 (as appropriate) will be assigned only if transcripts provided exhibit at least one hundred semester hours or one hundred fifty quarter hours of actual graded classroom instruction. Grades of Pass/Fail, Credit/No Credit will not count toward the 100/150 hour requirement.

A technical code of 1 or 0 ordinarily is assigned only to an officer whose undergraduate major was Physics, Aeronautical, Electrical, Mechanical or Naval Engineering, or whose undergraduate technical major is consistent with the officer's designator.

Example
An APC of 221 indicates a total grade average for all college courses in the interval 2.60-3.19, a complete sequence in calculus-of-one-variable with a C+ or B average and a major in physics or pertinent engineering area with upper-division courses with a C+ or B average.

Threshold
Each curriculum at the Naval Postgraduate School has a specified threshold APC for admission. A list of these is given at the beginning of the section on programs. Officers with deficient APCs may qualify for entry into these curricula by completing suitable courses at any accredited civilian college. Transcripts (not grade reports) of work done at civilian schools must be forwarded to the Director of Admissions, Code 62, Naval Postgraduate School, Monterey, CA 93943-5000, to effect an APC change. The grades in all courses completed will be used to revise an officer's QPR.

GENERAL INFORMATION

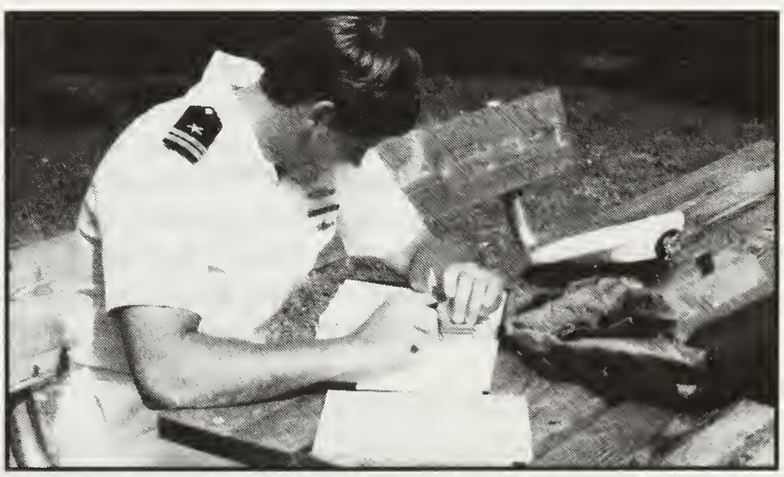
COURSE CODES

Courses are designated by an alpha-numeric symbol consisting of two letters and four numbers. The first two letters designate the academic department which offers the course and are defined as follows:

Administrative Sciences	AS
Service Courses	
Telecommunications Systems Management	CM
Information Systems	IS
Management	MN
Aeronautics and Astronautics	AE
Antisubmarine Warfare	ST
Command, Control and Communications	CC
Computer Science	CS
Electrical and Computer Engineering	EC
Electronic Warfare	EW
Interdisciplinary Courses	EO
Mathematics	MA
Mechanical Engineering	ME
Materials Science	MS
Meteorology	MR
National Security Affairs	NS
Oceanography	
Oceanographic Sciences	OC
Hydrographic Sciences	GH
Operations Research	
Operations Analysis	OA
Service Courses	OS
Physics	PH
Science and Engineering	SE
Space Systems	SS

Courses are assigned numbers in accordance with their level of academic credit:

0001-0999	No credit
1000-1999	Lower division college credit (Freshman - Sophomore Level)
2000-2999	Upper division college credit (Junior - Senior level)
3000-3999	Upper division college or graduate credit
4000-4999	Graduate credit



Following the course designator are two numbers in parentheses separated by a hyphen which indicate the hours of instruction per week in the classroom and in the laboratory, respectively. Laboratory hours are assigned half the value shown in calculating quarter hours for the credit value of the course. Thus a (3-2) course, having three hours lecture and two hours laboratory, will be assigned a credit value of four quarter hours.

GRADING

Student academic performance is evaluated in terms of quality points assigned to the letter grade achieved in a course. Based on the level of achievement associated with each letter grade, the corresponding quality point values range from a maximum of 4 to a minimum of 0 as follows:

Grade	Point Value
A	4
A-	3.7
B+	3.3
B	3
B-	2.7
C+	2.3
C	2
C-	1.7
D+	1.3
D	1
X	0

Letter designations for which no quality points are assigned are given as follows:

I	Incomplete
W	Withdrew
N	Ungraded
P	Pass
F	Fail

The grade of Incomplete is given when an identifiable portion of the course remains undone at the end of the quarter. One additional quarter is granted to submit the delinquent work. If the "I" is not removed within the twelve weeks following the end of the term in which it was assigned, it becomes an "X."

A student may withdraw from a course up to the end of the second week of the quarter without any record of it showing on the transcript. Withdrawals may be made after that up to the end of the eighth week of the quarter, but a grade of "W" is entered for the course on the transcript. No withdrawals can be made after the eighth week.

Courses may be designated for "P" and "F" grading when approved by the Academic Department and the Academic Council. A student in a degree program who wishes to take courses not in his or her normal program may elect to take them in the Pass/Fail mode. Approval must be granted by the student's cognizant Curricular Officer and Department Chairman. It is the responsibility of the student to exercise the P/F option by informing the instructor in writing at the time of enrollment that a P/F grade is desired. A copy of the approved request shall be forwarded to the Registrar. Students electing to receive the P/F grade in letter graded courses may not apply the hours toward the degree and curriculum requirements of any program.

QUALITY POINT RATING (QPR)

When the quarter-hour credit of a course is multiplied by the point value of the student's grade, a quality point value for the student's work in the course is obtained. The sum of the quality points for all courses divided by the sum of the quarter-hour credit of these courses gives a weighted numerical evaluation of the student's performance, termed the Quality Point Rating (QPR). A student achieving a QPR of 3.0 has maintained a "B" average in all courses undertaken with a proper weight assigned for course hours.

ACADEMIC COUNSELING

The NAVPGSCOL provides academic counseling services as indicated below to assist officers in developing individual educational plans. Officers who have chosen specific

curricula or who have been selected or detailed for graduate education in programs at NAVPGSCOL, are advised to contact the appropriate NAVPGSCOL curricular office listed in the Programs Section of this catalog. Officers not yet selected for graduate education and seeking general information about the curricula offered at the school, or for general information on the fully-funded graduate education selection process, are advised to contact the Director of Admissions (Code 62), NAVPGSCOL, or telephone (408) 656-3093, DSN 878-3093.

COURSE REGISTRATION AND CREDIT

Each student must be registered in each course in which he/she is a candidate for credit not later than the end of the second week of the term. No student will receive credit for a course unless registration in that course has been approved by one of the following: the student's Curricular Officer or Academic Associate, the Chairman of his/her doctoral committee, or the Dean of Instruction.

Overload: A student may not enroll for more than 21 total credit hours or more than four 3000 and/or 4000 courses (excluding laboratories or explicit curriculum requirements) per quarter unless he or she has either a total QPR of at least 3.50 or permission of the Department or Group Chairman and the Dean of Instruction.

Repetition of Courses: A student may repeat a course for the purpose of improving a grade when the grade received originally was either D or X, provided such course repetition is taken at the Postgraduate School. Approval must be granted by both the Curricular Officer and the Department Chairman concerned and the Registrar is to be notified.

For record purposes, both the original and the repeated courses are to be shown on the transcript. For Quality Point Rating computation, the credit hours of the course shall be counted once with the quality points earned being the average of the two.

Medical Absence: The academic record of a student may be deleted completely for a given term when the student is absent for a portion of the term for medical reasons. The transcript will show, "Excused for the term for medical reasons." The student shall not be permitted to delete only a portion of the courses for this reason. The grade "W" shall be used when it is necessary to withdraw from only a part of the student's program. Such excusals shall be requested by the Curricular Officer and approved by the Dean of Instruction.

Credit by Examination: The award of credit solely on the basis of examination for any 1000 or 2000 level course is permissible. Grades for such courses shall be awarded on a Pass/Fail basis.

VALIDATION

A student with the appropriate background may validate a course that is required for his/her curriculum. Validation will allow the student to omit that course from the program of study; however, no credit will be granted for a course that has been validated. The basic purpose of course validation is to make optimal use of the student's time at the Naval Postgraduate School. Every validation must be justified by documented evidence of prior work in the area of the course to be validated.

The validation of a course must be approved in writing by the Chairman of the department offering the course or a designated representative. Specific criteria for validation (e.g., review of the student's transcripts or examination on the material of the course) are left to the discretion of the cognizant Department Chairman.

After validating one or more courses, it may be possible for a student to complete the program in less than the maximum time allowed.

TRANSFER OF CREDITS

Upon entry to the Naval Postgraduate School, each student's academic record will be evaluated for possible transfer of credit or for exemption from portions of the curricular

program by validation of course work previously completed. Students may also utilize knowledge gained through self-study, experience of service-related education to seek validation, or credit for curricular courses by taking a departmental examination.

Twelve hours of graduate-level courses previously completed may be accepted for transfer credit. These include graduate-level courses taken after completion of the baccalaureate degree and those taken in the last term before award of the baccalaureate and certified to be in excess of degree requirements.

Questions on transfer credit should be directed by letter to the appropriate curricular Academic Associate, as listed in this catalog.

REQUIREMENTS FOR THE MASTER OF ARTS DEGREE AND THE MASTER OF SCIENCE DEGREE

The Master's Degree may be awarded for successful completion of a curriculum which has the approval of the Academic Council as meriting the degree. Such curricula shall conform to current practice in accredited institutions and shall contain a well-defined major.

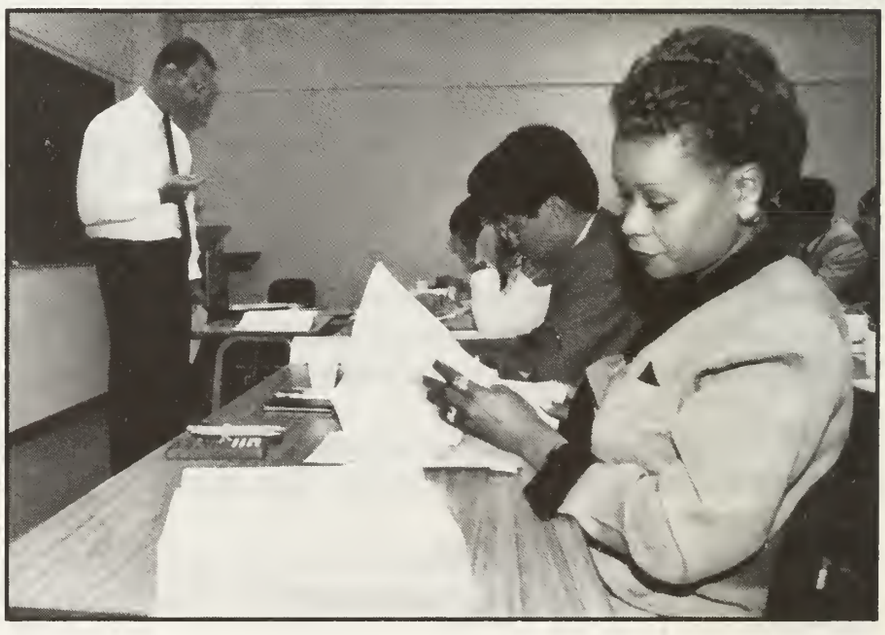
General Postgraduate School minimum requirements for the Master's Degree are as follows:

- 32 quarter hours of graduate level credits of which at least 20 quarter hours must be earned on campus.
- A thesis or its equivalent is required. If the thesis is waived, at least 8 quarter hours of approved courses 4000 - 4999 shall be substituted for it.

Admission to a program leading to the Master's degree requires:

- General undergraduate work as defined in Section 320 of the Academic Policy Manual.
- Appropriate undergraduate preparation for the curriculum to be pursued. A student entering the Postgraduate School with inadequate undergraduate preparation will be required to complete the undergraduate prerequisites in addition to the degree requirements.
- A demonstrated academic potential for completing the curriculum.

To be eligible for the Master's degree, the student must attain a minimum average quality point rating of 3.00 in all of the 3000 and 4000 level courses in his/her curriculum and either 2.5 in the remaining courses or 2.75 in all courses of the curriculum.



DUAL DEGREE PROGRAMS

Students who wish to pursue a dual degree program must satisfy QPR and other curricular/ departmental requirements, as set forth in the Academic Council Policy Manual.

CURRICULA CONDUCTED AT OTHER UNIVERSITIES

The Navy's fully-funded graduate education program supports 71 subspecialities. This involves 78 curricula, 35 at NPS and 36 at over 62 civilian institutions. Programs available at NPS are not offered at civilian institutions. Approximately 20% of the fiscal year officer graduate education assignments are slated for these universities. Where more than one school is listed for a particular curriculum, subspecialty education placement officers plan quota distribution.

In order to qualify for the Civilian Institutions program, officers must be Postgraduate School selected and must meet all the requirements of the civilian institution.

Curriculum	Number	Length	Institution	Primary Consultant
Chemistry	382	2 yrs.	Various	NAVSEASYSCOM
Criminal Law	884	1 yr.	Various	NJAG
Education and Training Management	867	12-18 mos.	Various	CNET
Environmental Law	880	1 yr.	Various	NJAG
Facilities Engineering	47X	1-2 yrs.	Various	NAVFACENGCOM
Health Care Law	885	1 yr.	Various	NJAG
International Law	887	1 yr.	Various	NJAG
Joint Intelligence	990	9-12 mos.	Defense Intell. Sch.*	NAVINTCOM
Labor Law	886	1 yr.	Various	NJAG
Advanced Military Justice	881	9-12 mos.	JAG School	NJAG
Logistics Management	770	15 mos.	Air Force Institute of Technology*	NAVAIRSYSCOM
National Security (International Relations and Diplomacy	680	12 mos.	Harvard (JFK School of Government) Tufts (Fletcher)	CNO OP-06
National Security (International Relations and Diplomacy)	690	12 mos.	Various	CNO OP-06
Naval Construction and Engineering	510	2-3 yrs.	M.I.T.	NAVSEASYSCOM
Nuclear Engineering (ED)	520	2 yrs.	M.I.T.	NAVSEASYSCOM
Nuclear and Directed-Energy Weapons and Effects	521	18 mos.	Air Force Institute of Technology*	CNO OP98IN
Ocean Engineering	472	15-18 mos.	Various	NAVFACENGCOM
Ocean Law	883	1 yr.	Various	NJAG
Operational Oceanography	375	27 mos.	M.I.T.	CNO OP-096
Petroleum Management	811	18-21 mos.	University of Kansas	NAVSUPSYSCOM
Petroleum Engineering	630	12-24 mos.	Various	NAVFACENGCOM
Public Affairs	920	1 yr.	Various	CHINFO
Religion	97X	9 mos.	Various	CHCHAP
Retailing	830	18-21 mos.	Various	NAVSUPSYSCOM
Subsistence Technology	860	18-21 mos.	Michigan State	NAVSUPSYSCOM
Supply Acquisition/ Distribution Management	810	18-21 mos.	NAVSUPSYSCOM	
Tax Law	882	1 yr.	Various	NJAG

*No NROTC Unit at Institution

Inquiries concerning curricula conducted at other universities should be directed to:

Manager, Civilian Institutions Program,
Naval Postgraduate School, Monterey, CA 93943.
Telephone (408) 656-2319 or DSN 878-2319.

Detailed information and the list of approved civilian institutions for the above curricula may be found in OPNAVNOTE 1520.

ADMINISTRATIVE SCIENCES PROGRAMS

Curricular Officer:
Michael P. Tryon
CDR,USN
Code 36, Ingersoll Hall
Room 219
(408) 656-2536, DSN 878-2536

TRANSPORTATION LOGISTICS MANAGEMENT CURRICULUM 813

This curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration into an understanding of the process by which the defense mission is accomplished. Inputs from the Navy are from the Supply Corps. These programs are designed to provide the officer with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis, and financial management; furthermore, it is intended to provide the officer with a Navy/Defense Systems-oriented graduate management education and to provide the officer with the specific functional skills required to effectively manage in this subspecialty area.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Supply Corps Officers from the U.S. Navy start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION LOGISTICS MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Material Movement Subspecialist, subspecialty code 1304P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:
Transportation Officer: CINCLANTFLT
Material Department Head: Fleet and Industrial Support Centers (FICS)
Air Terminal Coordinator: COMFAIRMED
Cargo Handling Officer, Operations Officer: NAVCHAPRU
CO and IX: NAVMTO
Deputy Commander: MTMC

ENTRY DATE

Transportation Logistics Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 813
Academic Associate:
Alan W. McMasters, Professor
Code AS/Mg, Ingersoll Hall, Room 209
(408) 656-2678, DSN 878-2678

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Transportation Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy Processes
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management

Quarter 4

IS3183	(4-0)	Management Information Systems
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN3301	(4-0)	Systems Acquisition and Project Management
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 6

MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN3111	(4-0)	Personnel Management Processes
MN3375	(4-0)	Materials Handling Systems Design

Quarter 7

MN0810	(0-0)	Research
MN3371	(4-0)	Contracts Management and Administration
MN3377	(4-0)	Inventory Management
MN4999	(4-0)	*Curriculum Option

*one additional course must be selected from the following curriculum options:
MN3374 Production Management: A TQM/L Perspective
MN4151 Internal Control and Auditing
MN4310 Logistics Engineering

TRANSPORTATION MANAGEMENT
CURRICULUM 814
The objectives of this curriculum are to prepare officers for naval logistics system positions, emphasizing worldwide transportation aspects. Graduate logistics courses cover topics such as the transportation system within CONUS, warehouse siting,

materials management, production management, inventory management (both Navy and private sector), materials handling, purchasing and physical distribution. Students take additional courses in transportation in the private sector and military transportation in support of contingencies, as well as options in corporate financial management, production management, or logistics engineering.

REQUIREMENTS FOR ENTRY
A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

TRANSPORTATION MANAGEMENT SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Transportation Management Subspecialist with a subspecialty code of XX35P. The Curriculum Sponsor is Military Sealift Command Headquarters.

Typical Jobs in this Subspecialty:
Commander: MSCO, COMSCEUR, COMSCMED, COMSCPAC, United Kingdom and Northen Europe
Tanker Control Officer: Military Sealift Command (MSC) Headquarters
Commander and Deputy Commander: Military Sealift Command Officer (MSCO), Norfolk, VA

ENTRY DATE
Transportation Management is a seven-quarter course of study with a single entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 814
Academic Associate:
Alan W. McMasters, Professor
Code AS/Mg, Ingersoll Hall, Room 209
(408) 656-2678, DSN 878-2678

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3373	(4-0)	Transportation Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3105	(4-0)	Organization and Management
MN3172	(4-0)	Public Policy Processes
MN4373	(4-0)	International Transportation Management
OS3006	(4-0)	Operations Research for Management

Quarter 4

IS3183	(4-0)	Management Information Systems
MN4145	(4-0)	Policy Analysis
MN4376	(4-0)	Defense Transportation System
MN3371	(4-0)	Contracts Management and Adminstration

Quarter 5

MN0810	(0-0)	Thesis Research
MN3301	(4-0)	Systems Acquisition and Project Management
NS3252	(4-0)	Joint and Maritime Strategic Planning
MN3111	(4-0)	Personnel Management Processes

Quarter 6

MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN3375	(4-0)	Material Handling Systems Design
MN4999	(4-0)	*Curriculum Option

Quarter 7

MN0810	(0-0)	Thesis Research
MN4999	(4-0)	*Curriculum Option
MN0810	(0-0)	Thesis Research
MN3154	(4-0)	Financial Management in the Armed Forces

*one additional course must be selected from the following curriculum options:

MN3374 Production Management: A TQM/L Perspective
MN4151 Internal Control and Auditing
MN4310 Logistics Engineering

ACQUISITION AND CONTRACT MANAGEMENT
CURRICULUM 815

The Acquisition and Contract Management Curriculum is an interdisciplinary program which integrates mathematics, accounting, economics, finance, behavioral science, management theory, operations/systems analysis and specific courses in acquisition and contracting. Inputs from the Navy are from the Supply Corps and civilians in the 1102 series. Marine Corps, Army and Coast Guard officers also participate in the program. The curriculum is designed to provide officers and civilians with the skills to serve effectively in hardware systems buying offices, field contracting offices, contract administration offices and contracting policy support offices.

The following are a sample of the ESRs of the curriculum as delineated by the curriculum sponsor:

1) Develop, implement and coordinate acquisition strategies, policies and plans.
2) Understand business finance and accounting; evaluate contractor proposals and capabilities.
3) Knowledge of system life cycle, economic analysis.
4) Have an in-depth comprehension of contract types.
5) Ability to evaluate requirements, specifications, bids, proposals and contractor performance.
6) Determine rights/obligations for settlement of controversies on government contracts.
7) Negotiate contracts and contractual issues.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ACQUISITION AND CONTRACT MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies Naval officers as Acquisition and Contract Management Subspecialists with a subspecialty code of 1306P, Army officers as Functional Area 51, and Marine Corps officers with a 9656 MOS. The Curriculum Sponsor is the Deputy to the Assistant Secretary of the Navy (Research, Development and Acquisition) for Acquisition Policy, Integrity and Accountability. The curriculum satisfies the mandatory Acquisition Enhancement (ACE) contracting courses required by the Defense Acquisition Workforce Improvement Act (DAWIA).

Typical Jobs in this Subspecialty:

Contracting Officer:
Ships Parts Control Center, Mechanicsburg, PA;
Aviation Supply Office, Philadelphia, PA

Director of Contracts:
Naval Supply Depots, Naval Supply Centers, Navy Laboratories, Navy Regional Contracting Centers

Procuring Contracting Officer, (PCO):
Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR), Washington, DC

Business/Financial Manager (B/FM):
Hardware Systems Commands (NAVAIR, NAVSEA, SPAWAR), Washington, DC

Contracts and Business Policy:
Staff of Assistant Secretary of the Navy (Research, Development and Acquisition)
Staff of Under Secretary of Defense (Acquisition)

Administrative Contracting Officer (ACO):
Defense Contract Management Command (DCMC)
Superintendent, Shipbuilding, Conversion and Repair (SUPSHIP)

ENTRY DATES

Acquisition and Contract Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 815
Academic Associate:
David V. Lamm, Associate Professor
Code AS/Lt, Ingersoll Hall, Room 248
(408) 656-2775, DSN 878-2775

DEGREE

Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting

MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
MN2302	(0-2)	Seminar for Aquisition and Contracting Students
IS0123	(0-2)	Computer Skills Development (as required)

Quarter 2

MN3303	(4-0)	Principles of Acquisition and Contracting
MN3140	(4-0)	Microeconomic Theory
MN3161	(4-0)	Managerial Accounting
OS3101	(4-1)	Statistical Analysis for Management
MN2302	(0-2)	Seminar

Quarter 3

MN3312	(3-0)	Contract Law
NS3252	(4-0)	Joint and Maritime Strategic Planning
MN3105	(4-0)	Organization and Management
MN3304	(5-2)	Contract Pricing and Negotiations
MN2302	(0-2)	Seminar

Quarter 4

MN3305	(3-0)	Contract Administration
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management Information Systems
MN3172	(4-0)	Public Policy Processes
MN2302	(0-2)	Seminar

Quarter 5

MN4301	(4-0)	Contracting for Major Systems
MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
OS3006	(4-0)	Operations Research for Management
MN2302	(0-2)	Seminar

Quarter 6

MN4371	(4-0)	Acquisition and Contracting Policy
MN4105	(4-0)	Management Policy
MN0810	(0-0)	Thesis Research
MN2302	(0-2)	Seminar

SYSTEMS ACQUISITION MANAGEMENT CURRICULUM 816

The Systems Acquisition Management Curriculum is an interdisciplinary program designed to integrate business principles, management theory, operations/systems analysis, and engineering applications. It is uniquely tailored to Defense acquisition management and intensive exposure to the fundamental principles of the acquisition environment. The courses in this curriculum present the structure of acquisition management, the decisions and problems facing the acquisition manager, the various forces at work within industry and Government, and the impact of acquisition policies and strategies. Student input includes officers and civilians from all DoD Services, the Coast Guard and Allied Nations.

The following are a sample of the ESRs of the curriculum as delineated by the sponsor:

1) Understand the influence acquisition policy formulation and execution.
2) Understand private industry business philosophies and concepts.
3) Understand the systems acquisition process.

4) Understand the basic concepts, functions, techniques and problems of program management.
5) Perform tradeoff decision analysis using performance, cost and schedule parameters.

REQUIREMENTS FOR ENTRY
A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, Allied officers and DoD civilian employees enter the curriculum with widely varied academic backgrounds. Each student's prior academic work and related experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credit may be transferred. Validation or credit by examination is encouraged where knowledge of the material has been acquired by experience or Service courses.

SYSTEMS ACQUISITION MANAGEMENT SUBSPECIALTY
Completion of this curriculum qualifies an Army officer for Functional Area 51 and a Marine Corps officer for MOS 9657. Department of Defense civilians are typically members of the acquisition workforce as specified by the Defense Acquisition Workforce Improvement Act (DAWIA). This curriculum satisfies the mandatory requirements for the Program Management Course (PMC) at the Defense Systems Management College (DSMC). The Curriculum Sponsor is the Military Deputy to the Assistant Secretary of the Army (Research, Development and Acquisition).

Typical Jobs in this Subspecialty:
Program Manager/Deputy Program Manager
    Army/Navy/Marine Corps Aircraft, Missile, Vehicle and Ship programs
Class Desk Officer
    Naval Air Systems Command
Program Executive Officer (PEO) staff
Matrix Organization staff
    Army Aviation Systems Command
    Naval Air Systems Command
    Naval Sea Systems Command
    Army Missile Command
    Army Communications and Electronics Command
    Marine Corps Systems Command
Test and evaluation officer
Logistics officer
    Marine Corps Logistics Base

ENTRY DATES
Systems Acquisition Management is a seven-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Assoicate for this curriculum or the Curricular Officer.

Curriculum 816
Academic Associate:
Dr. David V. Lamm, Associate Professor
Code AS/Lt, Ingersoll Hall, Room 248
(408)656-2775, DSN 878-2775

DEGREE
Requirements for the degree Master of Science in Mangement are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1		
MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
MN2303	(0-2)	Seminar for Program Management Students
IS0123	(0-2)	Computer Skills Development (as required)
Quarter 2		
MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3301	(4-0)	Systems Acquisition and Program Management
OS3104	(4-0)	Statistics for Science and Engineering
MN2303	(0-2)	Seminar for Program Management Students
Quarter 3		
MN3105	(4-0)	Organization and Management
MN3371	(4-0)	Contracts Management and Administration
OS3302	(4-0)	Quality Assurance and Reliability Methods
OS3006	(4-0)	Operations Research for Management Students
MN2303	(0-2)	Seminar for Program Management Students
Quarter 4		
MN4310	(4-0)	Logistics Engineering
MN4145	(4-0)	Policy Analysis
MN3154	(4-0)	Financial Management in the Armed Forces
IS3183	(4-0)	Management Information Systems
MN2303	(0-2)	Seminar for Program Management Students
Quarter 5		
MN3172	(4-0)	Public Policy Processes
NS3252	(4-0)	Joint and Maritime Strategic Planning
MN0810	(0-0)	Thesis Research
		Curriculum Option
Quarter 6		
MN4105	(4-0)	Management Policy
EC4010	(3-0)	Principles of Systems Engineering
OS4601	(4-0)	Test and Evaluation
MN0810	(0-0)	Thesis Research
MN2303	(0-2)	Seminar for Program Management Students
Quarter 7		
MN4307	(4-0)	Program Management Policy and Control
MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Reserach
		Curriculum Option
MN2303	(0-2)	Seminar for Program Management Students

ADMINISTRATIVE SCIENCES (NON USN) CURRICULUM 817

These programs are designed to provide the officers with fundamental interdisciplinary techniques of quantitative problem-solving methods, behavioral and management science, economic analysis and financial management and to enable the officers to evaluate the written research, study and analysis product of others throughout their careers. The curriculum will further provide the officers with the specific functional skills required to effectively manage.

These curricula are interdisciplinary programs which integrate mathematics, accounting, economics, behavioral science, management theory, operations/systems analysis and a subspecialty concentration area into an understanding of the process by which the defense mission is accomplished. Specialty concentration areas are specified by ordering officers into a specific curriculum.

While Allied students are free to choose any of the specific management curricula available, nearly half choose the more general Administrative Sciences International Curriculum 817. The 817 curriculum allows students to design a program of course work specific to management effectiveness in the host country's military system. The student may elect to specialize in the relevant portion of a functional area such as financial, logistics, human resources and organization, or manpower and personnel analysis. Or, the student may choose to follow a general management program which would include an overall balance of courses from many functional areas.

REQUIREMENT FOR ENTRY
A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as Allied officers and DoD employees, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military and civilian experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

ENTRY DATES
Administrative Sciences for USA, USCG, USMC, DoD civilians and allied officers is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associates for this curriculum or the Curricular Officer.

Curriculum 817A
Academic Associates:

Systems Acquisition Management
David V. Lamm
Code AS/LT, Ingersoll Hall, Room 248
(408) 656-2775, DSN 878-2741

USCG and DoD Civilians - Administrative Sciences
USMC - Defense Systems Analysis
James E. Suchan, Associate Professor
Code AS/Sa, Ingersoll Hall, Room 215A
(408) 656-2905, DSN 878-2905

International Officers - Administrative Sciences
Roger Evered, Professor
Code AS/Ev, Ingersoll Hall, Room 201
(408) 656-2646, DSN 878-2646

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

SYSTEMS ACQUISITION MANAGEMENT CURRICULUM (817A)

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making

MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development
MN2303	(0-2)	Seminar for Program Management Students

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3104	(4-0)	Statistics for Science and Engineering
MN3301	(4-0)	Systems Acquisition and Project Management

Quarter 3

MN2303	(0-2)	Seminar for Acquisition and Contracting Students
MN3371	(4-0)	Contracts Management and Administration
OS3006	(4-0)	Operations Research for Management
OS3302	(4-0)	Quality Assurance and Reliability
MN3105	(4-0)	Organization and Management

Quarter 4

MN4310	(4-0)	Logistics Engineering
MN4145	(4-0)	Policy Analysis
MN2303	(0-2)	Seminar for Program Management Students
IS3183	(4-0)	Management Information Systems
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5

MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN2303	(0-2)	Seminar for Program Management Students
NS3252	(4-0)	Joint and Maritime Strategic Planning
MN3172	(4-0)	Public Policy and Budgeting

Quarter 6

MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN4999		*Curriculum Option
OS4601	(4-0)	Test and Evaluation
EC4010	(3-0)	Principles of Systems Engineering
MN2303	(0-2)	Seminar for Program Management Students

Quarter 7

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN4307	(4-0)	Program Management Policy and Contract
MN2303	(0-2)	Program Management Seminar

COAST GUARD

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(3-1)	Organization and Management

OS3101	(4-0)	Statistical Analysis for Management
MN3902	(0-2)	MPT Computer Skills

Quarter 3

MN3111	(4-0)	Personnel Management Processes
MN3172	(4-0)	Public Policy Processes
MN4161	(4-0)	Financial Management Control Systems
MN4110	(4-2)	Multivariate Analysis 1

Quarter 4

MN4999		*Curriculum Option
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management Information Systems
OS3006	(4-0)	Operations Research for Management

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 6

MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN4105	(4-0)	Management Policy
MN4999		*Curriculum Option

MARINE CORPS

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN3172	(4-0)	Public Policy Processes
MN3301	(4-0)	Systems Acquisition and Project Management
OS3006	(4-0)	Operations Research for Management
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 4

OA4702	(4-0)	Cost Estimation
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management Information Systems
MN3154	(4-0)	Financial Management in the Armed Forces

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN4999		*Curriculum Option

Quarter 6

MN4999		*Curriculum Option
MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN4999		*Curriculum Option

INTERNATIONAL OFFICERS

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN4999		*Curriculum Option
MN4999		*Curriculum Option
MN3333	(4-0)	Managerial Communication Systems
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN4999		*Curriculum Option
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management Information Systems
MN4999		*Curriculum Option

Quarter 5

MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN4999		*Curriculum Option
MN4999		*Curriculum Option

Quarter 6

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Strategic Management
MN4999		*Curriculum Option

*Student must consult with academic associate to select additional courses that meet student and sponsor needs.

DoD CIVILIAN PROGRAM

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN4999		*Curriculum Option
MN3172	(4-0)	Public Policy Processes
MN4999		*Curriculum Option
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN4999		*Curriculum Option
MN4145	(4-0)	Policy Analysis
IS3183	(4-0)	Management Information Systems
MN4999		*Curriculum Option

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
MN4999		*Curriculum Option

Quarter 6

MN4999		*Curriculum Option
MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN4999		*Curriculum Option

*Student must consult with academic associate to select additional courses that meet student and sponsor needs.

SYSTEMS INVENTORY MANAGEMENT CURRICULUM 819

This curriculum emphasizes the management of Navy owned inventories at all levels. Curriculum 819 students take additional courses in general inventory model development and the specific details of the Navy's inventory models, spanning the three levels of wholesale, intermediate and retail customer support. Officers are responsible for developing procedures for establishing, maintaining and controlling inventories of material, distributing that material to the Navy customer, and developing the budgets for financing these inventories.

The Systems Inventory Management curriculum is interdisciplinary, integrating mathematics, accounting, economics, management theory, operations analysis and the specialty concentration into an understanding of the process by which the defense mission is accomplished.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the Navy's Supply Corps start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

SYSTEMS INVENTORY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies a naval officer as a Systems Inventory Management Subspecialist with a subspecialty code of 1302P. The Curriculum Sponsor is Naval Supply Systems Command Headquarters.

Typical Jobs in this Subspecialty:
Inventory Control Management: Naval Supply Depot/Naval Supply Center
Stock Control: Navy Shipyards
Head Inventory Control Point Polaris Material Office: Bremerton/Charleston
Director of Program Support Office Ships Parts Control Center: Mechanicsburg, PA
Director of Customer Support Office Ships Parts Control Center: Mechanicsburg, PA
Project Officer, Inventory Control Point (ICP) Resystemization Fleet Material Support Office: Mechanicsburg, PA
Director, Retail Management Division Fleet Material Support Office: Mechanicsburg, PA
Project Officer, Inventory Accuracy and LOGMARS Fleet Material Support Office: Mechanicsburg, PA
Director, ICP Design and Procedure Department Fleet Material Support Office: Mechanicsburg, PA

ENTRY DATES
Systems Inventory Management is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 819
Academic Associate:
Alan W. McMasters, Associate Professor
Code AS/Mg, Ingersoll Hall
Room 209
(408) 656-2678, DSN 878-2678.

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

***TYPICAL COURSE OF STUDY**

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3104	(4-0)	Statistics for Science and Engineering
MN3172	(4-0)	Public Policy Processes

Quarter 3

MN3372	(4-0)	Material Logistics
OS3006	(4-0)	Operations Research for Management
MN3377	(4-0)	Inventory Management
MN3105	(4-0)	Organization and Management

Quarter 4

OA3501	(4-0)	Inventory 1
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
IS3183	(4-0)	Management Information Systems

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategic Planning
OA4501	(4-0)	Seminar in Supply Systems

Quarter 6

MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN3154	(4-0)	Financial Management in the Armed Forces
MN3371	(4-0)	Contracts Management and Administration

*The following courses are available for the student to choose from if a course in validated:

MN3373 (4-0) Domestic Transportation Management
MN3374 (4-0) Production Management: A TQM/L Prespective
MN3375 (4-0) Materials Handling Systems Design
MN3111 (4-0) Personnel Mangaement Processes

MATERIAL LOGISTICS SUPPORT MANAGEMENT CURRICULUM 827

The Material Logistics Support Management curriculum emphasizes all of the aspects for providing integrated logistics support of weapons systems. Besides study in mathematics, accounting, economics, behavioral science, management theory and operations analysis, the curriculum delves into production management, inventory management, integrated logistic support, procurement and contract administration, systems acquisition and project management. Skills resulting from the curriculum will prepare those responsible for managing the various segments of a military system's life cycle from initial planning for support to fielding the system, through sustaining operations to phaseout.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

MATERIAL LOGISTICS SUPPORT MANAGEMENT SUBSPECIALIST

Completion of this curriculum qualifies an officer as a Material Logistics Support Management Subspecialist, subspecialty code XX32P. The Curriculum sponsor is Naval Air Systems Command Headquarters.

Typical Jobs in this Subspecialty:

Aircraft Intermediate Maintenance: Naval Air Stations
Project Management Staff: Naval Air Systems Command, Washington, DC
Integrated Logistics Support
Coordinator for Operational Support: Naval Air Systems Command, Washington, DC
Director of Receiving Naval Supply: Depot/Naval Supply Center
Director of Storage Naval Supply: Depot/Naval Supply Center

ENTRY DATES

Material Logistics Support Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 827
Academic Associate:
Alan W. McMasters, Professor
Code AS/Mg, Ingersoll Hall
Room 209
(408) 656-2678, DSN 878-2678.

DEGREE
Requirements for the degree Master of Science in Management are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3101*	(4-1)	Statistical Analysis for Management
MN3172	(4-0)	Public Policy Processes

Quarter 3

MN3372	(4-0)	Material Logistics
MN3301	(4-0)	Systems Acquisition and Project Management
OS3006	(4-0)	Operations Research for Management
MN3105	(4-0)	Organization and Management

Quarter 4

MN3371	(4-0)	Contracts Management and Administration
MN4145	(4-0)	Policy Analysis
MN4310	(4-0)	Logistics Engineering
IS3183	(4-0)	Management Information Systems

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN3374	(4-0)	Production Management
MN4999	**Curriculum Option	

Quarter 6

MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN3154	(4-0)	Financial Management in the Armed Forces
NS3252	(4-0)	Joint and Maritime Strategic Planning

*OS3104 may be taken instead of OS3101. This substitution will allow certain curriculum option courses to be taken from the Operations Research department. The decision to take OS3104 must be made early in the first quarter.

**Curriculum Options:

MN3374	Production Management: A TQM/L Perspective
MN3154	Financial Management in the Armed Forces
MN4151	Internal Control and Auditing
MN4162	Cost Accounting

MN4302 Defense Resource Policy and Management
MN4310 Logistics Engineering
MN4372 Seminar in Acquisition and Contract Management

FINANCIAL MANAGEMENT
CURRICULUM 837

The objective of the Financial Management Curriculum is to prepare officers for business and financial positions within the Navy. Financial Managers assist the Navy's decision-making processes at all levels by providing accurate, timely and relevant information. They are concerned with the optimal allocation of human, physical and financial resources to achieve the Navy's goals and objectives while assuring efficient and effective expenditure of public funds.

Graduate courses cover topics such as financial reporting standards, cost standards, cost analysis, budgeting, internal control, financial auditing, operational auditing, management planning and control systems, quantitative techniques used in planning and control, and the Planning Program and Budgeting System used within the Department of Defense.

Graduates of the Financial Management Curriculum will be prepared for assignment to positions in budgeting, accounting, business and financial management, and Internal Control and Auditing.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. An APC of 345 is required for entry.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Each student's prior academic work and related military experience is evaluated for courses previously completed and applicable to the student's curriculum so that academic credits may be transferred. Validation or credit by examination is encouraged.

FINANCIAL MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Financial Management Subspecialist, subspecialty code XX31P. The Curriculum Sponsor is OP-82, Fiscal Management Division.

Typical Jobs in this Subspecialty:

Comptroller: Naval Air Stations
Budgeting Commander: Naval Medical Command, Washington, DC
Accounting Commander: Naval Medical Command, Washington, DC
Budget Officer Commander: Naval Air Forces Atlantic, Norfolk, VA
Comptroller: Naval Supply Depots/Naval Supply Centers
Fiscal Officer: Naval Supply Depots/Naval Supply Centers
Public Works Officer: Weapons Stations, CONUS
Cost Analysis Office of Secretary of the Navy: Washington, DC
Special Assistants Program: Planning Office (NAVY), Fiscal Management Division (OP-82)

ENTRY DATES

Financial Management is a six-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 837
Academic Associate:
Joseph G. San Miguel, Professor
Code AS/Sm, Ingersoll Hall
Room 318
(408) 656-2187, DSN 878-2644.

DEGREE
Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MN3333	(4-0)	Managerial Communication Skills
MA2300	(5-0)	Mathematics for Management
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Management Accounting
MN3140	(4-0)	Microeconomic Theory
MN3105	(4-0)	Organization and Management
OS3101	(4-1)	Statistical Analysis for Management

Quarter 3

MN4161	(4-0)	Management Control Systems
MN3172	(4-0)	Public Policy and Budgeting
MN4162	(4-0)	Cost Accounting
OS3006	(4-0)	Operations Research for Management

Quarter 4

MN3154	(4-0)	Financial Management in the Armed Forces
MN4145	(4-0)	Policy Analysis
MN4151	(4-0)	Internal Control and Auditing
IS3183	(4-0)	Management Information Systems

Quarter 5

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4999		*Curriculum Option
NS3252	(4-0)	Joint and Maritime Strtaegic Planning

Quarter 6

MN3301	(4-0)	Systems Acquisition and Project Management
MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN4999		*Curriculum Option

*Curriculum Options:

MN3374	Production Management: A TQM/L Perspective
MN3154	Financial Management in the Armed Forces
MN4151	Internal Control and Auditing
MN4162	Cost Accounting
MN4302	Defense Resource Policy and Management
MN4310	Logistics Engineering
MN4372	Seminar in Acquisition and Contract Management

MANPOWER, PERSONNEL AND TRAINING ANALYSIS CURRICULUM 847

Officers enrolled in the Manpower, Personnel and Training Analysis (MPTA) curriculum at the Naval Postgraduate School undertake the challenge of an academic program designed to fill the leadership roles in military manpower management. The XX33 Subspecialty has primary responsibility for developing and analyzing policies to ensure that the Navy is recruiting, training, utilizing and retaining personnel in the most efficient and effective ways possible. MPTA is an extremely analytical curriculum intended to develop skills necessary to perform and evaluate manpower analyses. As such, the curriculum emphasizes mathematical, statistical and other quantitative methods. Successful completion of the curriculum yields an officer skilled in conducting manpower policy analysis.

The areas covered in the MPTA curriculum include an understanding of MPT policy development, compensation systems, productivity analysis, enlistment supply and retention models, manpower training models, manpower requirements determination processes, career mix, enlistment incentives, reenlistment incentives, training effectiveness measures and hardware/manpower trade-offs. Students gain familiarity with current models and methods of MPT analysis as well as military MPT organizations and issues.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades is required. Completion of at least two semesters of college algebra or trigonometry is considered to be the minimum mathematical preparation. Additional preparation in calculus and statistics is considered very advisable. An APC of 345 is required for entry.

Prospective students electing MPTA as a subspecialty must be adequately prepared by their undergraduate curriculum and comfortably oriented to a quantitatively rigorous graduate curriculum.

Officers from the U.S. Services, as well as all others, start the curriculum with widely varied academic backgrounds. Validation by examination is encouraged.

MANPOWER, PERSONNEL AND TRAINING ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Manpower, Personnel and Training Analyst Subspecialist, subspecialty code XX33P. The Curriculum Sponsor is OP-13, Military Personnel Policy Division.

Typical Jobs in this Subspecialty:

Head, Ship Manpower Requirements Section:
- Deputy Chief of Naval Operations (Manpower, Personnel and Training)
- Director Total Force Programming/Manpower Division OP-12, Washington, DC

Programmed Objective Memorandum (POM) Operations:
- Deputy Chief of Naval Operations (Manpower, Personnel and Training)
- Director Total Force Programming/Manpower Division, OP-12, Washington, DC

Manager (OP-12A):
- Deputy Chief of Naval Operations (Manpower, Personnel and Training)
- Director Total Force Programming/Manpower Division OP-12, Washington, DC

Total Force Mobilization Plans Branch:
- Deputy Chief of Naval Operations (Manpower, Personnel and Training)
- Director Military Personnel Policy Division (OP-134G), Washington, DC

Head, Officer Procurement Plans Section (OP-130D)

ENTRY DATES

Manpower, Personnel and Training Analysis is a seven-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate for this curriculum or the Curricular Officer.

Curriculum 847
Academic Associate:
Mark J. Eitelberg, Associate Professor
Code AS/Eb, Ingersoll Hall, Room 234
(408) 656-3160, DSN 878-3160

DEGREE

Requirements for the degree Master of Science in Management are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MN2150	(4-0)	Financial Accounting
MN2031	(4-0)	Economic Decision Making
MA2300	(5-0)	Mathematics for Management
MN2111	(0-2)	Seminar in MPTA Issues
IS0123	(0-2)	Computer Skills Development

Quarter 2

MN3161	(4-0)	Managerial Accounting
MN3140	(4-0)	Microeconomic Theory
OS3101	(4-1)	Statistical Analysis for Management
MN2112	(0-2)	Seminar in MPTA Issues
MN3902	(0-2)	Computer Skills Enhancement

Quarter 3

MN3760	(4-0)	Manpower Economics
MN3333	(4-0)	Managerial Communication Skills
MN3105	(4-0)	Organization and Management
MN4110	(5-2)	Multivariate Manpower Data Analysis 1
MN2113	(0-2)	Seminar in MPTA Issues

Quarter 4

MN4761	(4-0)	Applied Manpower Analysis
MN4111	(5-2)	Multivariate Manpower Data Analysis 2
MN3111	(4-0)	Personnel Processes
OS3006	(4-0)	Operations Research for Management

Quarter 5

MN0810	(0-0)	Thesis Research
MN4115	(4-0)	Training Foundations and Management
NS3252	(4-0)	Joint and Maritime Strategic Planning
OS4701	(4-0)	Manpower and Personnel Models

Quarter 6

MN0810	(0-0)	Thesis Research
MN3172	(4-0)	Public Policy Processes
IS3183	(4-0)	Management Information Systems
MN4106	(4-0)	Manpower/Personnel Policy Analysis

Quarter 7

MN0810	(0-0)	Thesis Research
MN0810	(0-0)	Thesis Research
MN4105	(4-0)	Management Policy
MN4119		Seminar in Manpower Analysis

EDUCATIONAL SKILL REQUIREMENTS
TRANSPORTATION LOGISTICS MANAGEMENT
CURRICULUM (813)

Upon graduation the student will have acquired the following:

1) The ability to apply mathematical, statistical, accounting, economic and other state of the art techniques and concepts.

2) A thorough knowledge of basic management theory and practice, embracing the organization, staffing, directing, planning and controlling of enterprises.

3) An ability to design, procure and manage complex defense transportation systems in support of stock point physical distribution and other military logistics requirements. To do this requires an understanding of the defense acquisition process, Navy contracts management, the concepts and practices of financial management in the Navy and DoD, and domestic and international private sector transportation systems and their impact on the joint defense transportation environment.

4) An ability to actively participate in defense transportation contingency planning and the associated mobilization of transportation resources.

5) An understanding of joint and maritime strategic planning, to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

6) The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

EDUCATIONAL SKILL REQUIREMENTS
TRANSPORTATION MANAGEMENT
CURRICULUM (814)

Upon graduation the student will have acquired the following:

1) The ability to apply mathematical, statistical, accounting, economic and other state of the art techniques and concepts of systems analysis to management problems.

2) An ability to participate in the diagnosis, design, acquisition, implementation and operation of complex defense systems. To do this requires an understanding of the defense acquisition process, Navy contract management, and the concepts and practices of financial management in the Navy and DoD.

3) An ability to apply current innovations in personnel management to the management of civilian and military personnel.

4) An understanding of domestic and international private sector, transportation systems and their impact on the joint defense transportation environment. An understanding of federal regulations and the regulatory structure for domestic and ocean transportation is required.

5) An ability to participate in defense transportation and strategic sealift contingency and mobilization planning and execution.

6) An ability to conduct independent research on a transportation management problem, to resolve the problem and to present the results of the analysis in both written and oral form.

7) An understanding of military and maritime strategic planning, including strategic sealift, tactical and strategic Naval doctrine, as well as emerging technical developments and their potential effect upon the prosecution of tactical and strategic Naval warfare by the United States, its allies and its potential adversaries. Familiarity with the roles and missions of the military services, the history of general and joint staffs in the U.S. and abroad, joint planning for acquisition and operations, and current issues in defense reform and reorganization in both civilian and military facets.

EDUCATIONAL SKILL REQUIREMENTS ACQUISITION AND CONTRACT MANAGEMENT CURRICULUM (815)

1) An understanding of the principles and fundamentals of acquisition and contracting within the Federal Government, including the Federal Acquisition Regulation (FAR) and the DoD FAR supplement.

2) The ability to formulate and execute acquisition policies, plans, strategies and procedures.

3) A knowledge of the Government organization for acquisition including Congress, the General Accounting Office, the Office of Federal Procurement Policy, the buying offices, the Boards of Contract Appeals and the court system.

4) The ability to manage the field purchasing, system acquisition and contract administration processes using the sealed bid, competitive proposal and small purchase contracting methodologies.

5) An understanding of the system life-cycle process including requirements determination, funding, contracting, ownership and disposal.

6) An understanding of the business philosophy, concepts and methodologies of private industry and the ability to apply these to the military acquisition environment.

7) A comprehensive knowledge of all contract types and their application, with particular emphasis on contract negotiations.

8) The ability to evaluate requirements, specifications, bids and proposals.

9) The ability to apply economic and accounting principles, including monetary and fiscal theories, to acquisition and contracting issues.

10) An understanding of Joint and Maritime Strategic Planning.

11) The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

EDUCATIONAL SKILL REQUIREMENTS SYSTEMS INVENTORY MANAGEMENT CURRICULUM (819)

1) The ability to apply mathematical, statistical, accounting, economic and other state-of-the-art techniques and concepts of systems analysis to management problems.

2) A thorough knowledge of basic management theory and practice, embracing the organization, staffing, directing, planning and controlling of enterprises.

3) The ability to participate in the design, acquisition, operation and support of complex defense systems. To do this requires an understanding of the defense acquisition, process, the DoN/DoD logistics systems, Navy contracts management, the concepts and practices of financial management in the Navy and DoD, the concept of materials management and all of the elements associated with integrated logistics support.

4) The ability to integrate the procurement process, financial budgeting and control systems, transportation systems, supply information systems, inventory control, and requirements determination process as they apply to inventory management in the Navy. These processes and systems must be managed so as to give effective support to operating forces while eliminating waste and inefficiency in the acquisition and management of Navy and DoD supplies and inventories.

5) An understanding of Joint and Maritime Strategic Planning.

6) The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

EDUCATIONAL SKILL REQUIREMENTS
MATERIAL LOGISTICS SUPPORT MANAGEMENT
CURRICULUM (827)

Officers completing this curriculum will achieve the following:

The ability to apply mathematical, statistical, accounting, economic and other state-of-the-art techniques and concepts of systems analysis to management problems.

A thorough knowledge of basic management theory and practice, embracing the organization, staffing, directing, planning and controlling of enterprises.

The ability to participate in the design, acquisition, operation and support of complex defense systems. This requires an understanding of the defense acquisition process, the DoD/DoN logistics system, Navy contracts management, the concepts and practices of financial management in the Navy and DoD, the concepts of production and materials management and all the elements associated with integrated logistics support.

An understanding of Joint and Maritime Strategic Planning.

The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

EDUCATIONAL SKILL REQUIREMENTS
FINANCIAL MANAGEMENT
CURRICULUM (837)

Officers completing this curriculum will achieve the following:

A comprehensive understanding of all aspects of the DoN budget cycle including planning, programming and budget execution.

The ability to identify, analyze and prepare effective economic program alternatives in the financial management process. An ability to prepare and evaluate cost estimates.

The ability to manage and control funds to support approved programs.

The ability to develop and review financial reports and analyze budget execution against operating and financial plans. An ability to recommend or make management decisions regarding the reallocation or reprogramming of funds.

A comprehensive knowledge of the principles of finance and business management sufficient to support participation in the development, implementation and administration of fiscal policies, procedures, systems and controls to ensure the responsible use of available resources.

The ability to develop and use internal review and audit techniques to establish sound management controls.

An understanding of the acquisition process as it relates to procurement and development appropriations, and an understanding of the management and control of revolving and non-appropriated funds.

An understanding of Joint and Maritime Strategic Planning.

The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

EDUCATIONAL SKILL REQUIREMENTS
MANPOWER, PERSONNEL AND TRAINING ANALYSIS
CURRICULUM (847)

Officers completing this curriculum will have an understanding of the fundamental concepts and basic functional areas of Manpower, Personnel and Training (MPT) within DoN/DoD including:

Manpower: Requirements determination (authorizations, billet costs, end-strength development, mobilization) and the relationship to defense planning, programming, budgeting and acquisition processes.

Personnel: Recruiting and enlistment process and standards, DoN enlisted force management system, officer community management; attrition and retention issues; compensation issues.

Training: Theory of training, evolving instructional technology; evaluation of training effectiveness and cost; relationship between training and fleet readiness.

The ability to apply contemporary management principles and social science methodology to the development, implementation and management of effective MPT policies and programs in DoN/DoD.

The ability to analyze critically the strengths and weaknesses of proposed MPT policies, and to suggest alternatives which recognize the potential impact of policy proposals on DoN/DoD program planning, resources and objectives.

The ability to apply a range of quantitative techniques in conjunction with current MPT data bases and manpower planning models in analyzing MPT plans and policies.

The ability to use and understand computer systems in problem solving and analysis efforts, specifically as they relate to existing and proposed DoN/DoD management information systems.

An understanding of the planning, programming and budgeting system and the ability to analyze the impact of budgetary changes on DoN/DoD programs and policies.

An understanding of Joint and Maritime Strategy Planning, naval doctrine, and the effect of technical developments on warfare.

The ability to recognize scientific advancements of potential value to the Navy, formulate a research program, perform the necessary research and report the results.

AERONAUTICAL ENGINEERING PROGRAMS

Curricula Officer:
Wade D. Duym
CDR, USN
Code 31, Halligan Hall
Room 133
(408) 656-2491
DSN 878-2491

AERONAUTICAL ENGINEERING AND AERONAUTICAL ENGINEERING (AVIONICS) CURRICULA 610 and 611

The Aeronautical Engineering programs are designed to meet the specific needs of the Navy for technical managers with a broad-based graduate education in Aeronautical Engineering. While an undergraduate degree in engineering is preferred, special preparatory programs can accommodate officers backgrounds in mathematics or the sciences.

The Aeronautical Engineering programs are designed to give the student a broad technical and engineering education in the four principal areas of aeronautics: gas dynamics, flight dynamics, propulsion and flight structures. Additionally, officers receive graduate level instruction in aircraft/missile design and aero-computer science. Students in the 611 Curriculum receive primary emphasis on avionics systems. The programs are divided into preparatory, graduate and advanced graduate phases. The preparatory phase is tailored to each officer's background and is programmed for minimum time consistent with capability. After the preparatory phase, a graduate core is completed by both the 610 and 611 students. This phase includes advanced studies in propulsion, aerodynamic analysis, structural analysis and stability and control. During the advanced graduate phase, all students receive in-depth graduate coverage through advanced electives in areas of their choice including flight dynamics, gas dynamics, propulsion and structures. Students in Curriculum 611 receive advanced studies in guidance and control, radar systems and electronic warfare, aeronautical data systems and avionics design.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, with an above-average QPR, preferably in engineering or the physical sciences, is required. In addition, mathematics through differential and integral calculus, with above-average grades and completion of a calculus-based physics sequence with above-average grades is also required. An APC of 323 is the requirement for direct entry, but the Engineering Science Program (Curriculum 460) is available for candidates who do not meet all the admission requirements for direct entry. The required APC for entry via Curriculum 460 is 334.

ENTRY DATES

Aeronautical Engineering is an eight-quarter course of study with entry dates in April and October. Those requiring the Engineering Science Curriculum will have their time of arrival adjusted to accommodate it. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curricular 610 and 611
Academic Associate:
Gerald H. Lindsey, Professor
Code AA/Li, Halligan Hall
Room 223
(408) 656-2808, DSN 878-2808

DEGREE

Requirements for the degree Master of Science in Aeronautical Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular programs.

AERONAUTICAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Aeronautical Engineering Subspecialist with a subspecialty code of XX71P.
The Curriculum Sponsor and primary consultant is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:
Project Officer: Naval Air Systems Command
Project Officer: Naval Aviation Depot, Pensacola, FL
Aircraft Class Desk Officer: COMNAVAIRLANT, Norfolk, VA
Project Officer: Defense Plant Representative Office, St. Louis, MO
Instructor, Aeronautical Engineering: U.S. Naval Academy, Annapolis, MD
Deputy Project Manager: Naval Air Systems Command
Aircraft Class Deck Officer: COMNAVAIRPA, San Diego, CA

TYPICAL COURSE OF STUDY

Quarter 1

AE2042	(3-2)	Fundamentals of Thermo-fluid Dynamics
AE2440	(3-2)	Introduction to Digital Computation
MA2121	(4-0)	Differential Equations
ME2601	(3-2)	Mechanics of Solids

Quarter 2

AE2021	(4-1)	Introduction to Flight Structures
AE2035	(3-2)	Basic Aerodynamics
AE2043	(3-2)	Fundamentals of Gas Dynamics
MA2049	(4-0)	Vector Analysis

Quarter 3

AE2036	(3-2)	Performance and Static Stability
AE2801	(3-2)	Aero - Laboratories I
EC2420	(3-0)	Linear Systems
MA3132	(4-0)	Partial Differential Equations and Integral Transforms

Quarter 4

AE3101	(3-2)	Flight Vehicle Structural Analysis
AE3340	(3-2)	Linear Vibration and Dynamic Stability
AE3451	(3-2)	Aircraft and Missile Propulsion
AE3501	(3-2)	Current Aerodynamic Analysis

Quarter 5

AE3202	(3-2)	Structural Failure, Fracture and Fatigue
AE3341	(3-2)	Aerospace Controls
AE3802	(3-2)	Aero-Laboratories II
AE4632	(3-2)	Computer Methods in Aeronautics

Quarter 6

AE4201	(3-2)	Reliability and Systems Safety
AE4273	(3-2)	Aircraft Design
AE0810	(0-0)	Thesis Research
MS3201	(3-2)	Materials Science and Engineering

Quarter 7

AE4XXX		Elective
AE4XXX		Elective
AE0810	(0-0)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 8

AE4XXX		Advanced Elective
AE4XXX		Advanced Elective
AE0810	(0-0)	Thesis Research
AE0810	(0-0)	Thesis Research

AERONAUTICAL ENGINEERING (AVIONICS) SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Aeronautical Engineer with an Avionics Subspecialty and a subspecialty code of XX72P. The Curriculum Sponsor is the Naval Air Systems Command.

Typical Jobs in this Subspecialty:
Avionics Class Desk Officer: COMNAVAIRLANT, Norfolk, VA
Avionics Systems Project Officer: Naval Air Systems Command
Deputy Program Manager: Naval Air Systems Command
Project Officer: Naval Air Warfare Center (Aircraft Division), Warminster, PA

TYPICAL COURSE OF STUDY

Quarter 1

AE2042	(3-2)	Fundamentals of Thermo-fluid Dynamics
AE2440	(3-2)	Introduction Digital Computation
EC2210	(3-2)	Electronics Engineering
MA2049	(4-0)	Vector Analysis

Quarter 2

AE2035	(3-2)	Basic Aeronautics
AE2043	(3-2)	Fundamentals of Gas Dynamics
EC2600	(4-0)	Introduction to Fields and Waves
MA2121	(4-0)	Differential Equations

Quarter 3

AE2036	(3-2)	Performance and Static Stability
EC2410	(3-0)	Fourier Analysis of Signals and Systems
EC2420	(3-0)	Linear Systems
EC2610	(3-1)	Electromagnetic Engineering

Quarter 4

AE3340	(3-2)	Linear Vibration and Dynamic Stability
AE3451	(3-2)	Aircraft and Missile Propulsion
EC3600	(3-2)	Electromagnetic Radiation, Scattering and Propogation
MA3132	(4-0)	Partial Differential Equations and Integral Transforms

Quarter 5

AE3276	(3-2)	Introduction to Avionics
AE3341	(3-2)	Aerospace Controls
AE4641	(3-2)	Aeronautical Data Systems
EC2500	(3-2)	Communications Theory

Quarter 6

AE4276	(3-2)	Avionics System Design
AE4342	(3-2)	Advanced Control for Aerospace Systems
EC3670	(4-2)	Principles of Radar Systems
AE0810	(0-0)	Thesis Research

Quarter 7

NS3252	(4-0)	Joint and Maritime Strategic Planning
AE4XXX		Elective
AE4XXX		Elective
AE0810	(0-0)	Thesis Research

Quarter 8

AE4201	(3-2)	Reliability and Systems Safety
EC4670	(4-1)	Electronic Warfare
AE0810	(0-0)	Thesis Research
AE0810	(0-0)	Thesis Research

NPS/TPS COOPERATIVE PROGRAM

A program which combines portions of the 610 curriculum at the NPS with the completed U.S. Naval Test Pilot School syllabus is currently available to selected officers with strong undergraduate engineering backgrounds. After the completion of five quarters of study at NPS, selectees proceed to Patuxent River for the full Test Pilot School Curriculum. This NPS/TPS Cooperative Program results in a test pilot designation, XX73G, the Aeronautical Engineering subspecialty code XX71P and award of the master's degree in Aeronautical Engineering at the completion of the test pilot school.

TYPICAL COURSE OF STUDY

Quarter 1

AE2021	(4-1)	Introduction to Flight Structures
AE2035	(3-2)	Basic Aerodynamics
MA2047	(4-0)	Linear Algebra and Vector Analysis
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 2

MA2121	(4-1)	Differential Equations
AE3802	(3-2)	Aeronautical Measurement Techniques
AE2042	(3-2)	Fundamentals of Thermo-Fluid Dynamics
MS3201	(3-2)	Materials Science and Engineering

Quarter 3

MA3132	(4-0)	Partial Differential Equations
AE3501	(3-2)	Current Aerodynamic Analysis
AE2043	(3-2)	Fundamentals of Gas Dynamics
AE3101	(3-2)	Flight Vehicle Structural Analysis

Quarter 4

AE3202	(3-2)	Structural Failure, Fracture and Fatigue
AE4632	(3-2)	Computer Methods in Aeronautics
AEXXX		Elective
AEXXX		Elective

Quarter 5

AE4273	(3-2)	Aircraft Design
AE3251	(4-1)	Aircraft Combat Survivability
AE4201	(4-0)	Reliability Engineering and System Safety Management
AEXXX		Elective

EDUCATIONAL SKILL REQUIREMENTS AERONAUTICAL ENGINEERING CURRICULUM (610)

Education requirements for the officers completing this curriculum consist of a core set of prescribed aeronautical engineering essentials, which are required of all entrants regardless of background preparation, plus a set of five optional specialty tracks of advanced topics, from which the students can select as many as his/her background will allow in the time allotted for graduate study.

CORE REQUIREMENTS

FLIGHT STRUCTURES: A knowledge of the behavior of structural components under conditions of static loads; fundamental principles of material science; theories of failure, damage, buckling, fatigue, nondestructive evaluation and repair of naval flight vehicles.

FLIGHT DYNAMICS: An understanding of basic aerodynamics, performance, static and dynamic stability, classical control concepts and an introduction to optimal control and stochastic processes applicable to aircraft and missiles.

FLIGHT PROPULSION: An understanding of the principles of aircraft and missile propulsion and the ability to analyze the performance of gas turbines, rockets and ramjets through a knowledge of the behavior of the individual components.

GAS DYNAMICS: An understanding of one-dimensional compressible flow principles and two-dimensional classical subsonic and supersonic aerodynamics, and an introduction to boundary-layer theory and heat transfer concepts.

INFORMATION PROCESSING: The ability to use modern computer methods in aeronautical engineering analysis; a knowledge of the applications of computers in naval flight vehicles.

ENGINEERING MATHEMATICS: A demonstrated analytic ability in differential and integral calculus, ordinary and partial differential equations, operational calculus, complex functions, vector calculus, matrix algebra, numerical analysis, probability and statistics in experimental analysis, system safety, maintainability, reliability and survivability.

ELECTRICAL ENGINEERING: An understanding of electrical circuits, systems, and electronic devices.

SYSTEMS: An ability to integrate the specialty areas of aeronautics in the design of flight vehicles in response to a realistic set of military requirements, specifications and constraints. This ability will include concerns for safety, reliability, maintainability and survivabilty.

JOINT AND MARITIME STRATEGIC PLANNING: A knowledge of Joint and Maritime Strategic Planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

RESEARCH AND DEVELOPMENT: A knowledge of research and development programs applicable to current and future needs of Naval Aviation. An actual research and development experience will culminate in the publication of a thesis of both academic quality and relevance to Naval Aviation.

SPECIALIZATION OPTIONS

STRUCTURES: An understanding of finite element analysis; composite material construction and analysis; behavior of structural components under dynamic loads and structural design.

FLIGHT DYNAMICS: An understanding of rotary wing aerodynamics, performance and dynamics; flight test evaluation and engineering; and aeroelasticity principles.

FLIGHT PROPULSION: An understanding of the conversion of energy in aerodynamic design of computational analysis of the flow through compressors and turbines; combustion in gas turbines, combustion and thrust production in solid rocket and ramjet engines. The ability to use computer codes to select and size a ramjet or gas turbine engine for a given mission and carry out the preliminary design of its components.

GAS DYNAMICS: An understanding of transonic and hypersonic flows, rarefield gas dynamics, convective heat and mass transfer and computation fluid dynamics.

SYSTEMS: An understanding of the analysis, design and development aspects of complete weapons systems, utilitzing interdisciplinary engineering principles and modern systems case studies; an understanding of qualitative and quantitative risk assessment techniques, statistical decision-making, and reliability prediction as they are integrated into the Navy Safety program; and an understanding of combat survivability technology and assessment methodology.

EDUCATIONAL SKILL REQUIREMENTS AERONAUTICAL ENGINEERING (AVIONICS) CURRICULUM (611)

Education requirements for the officers completing this curriculum consist of a core set of prescribed aeronautical engineering essentials, which are required of all entrants regardless of background preparation, plus a set of four optional specialty tracks and advanced topics, from which the students can select as many as his/her background will allow in the time allotted for graduate study.

CORE REQUIREMENTS

FLIGHT STRUCTURES: A knowledge of the behavior of structural components under conditions of static loads.

FLIGHT DYNAMICS: An understanding of basic aerodynamics, performance, static and dynamic stability, classical control concepts and introduction to optimal control, including Kalman Filters, applicable to aircraft and missiles.

FLIGHT PROPULSION: An understanding of the principles of aircraft and missile propulsion and the ability to analyze the performance of gas turbines, rocket and ramjet engines through a knowledge of the behavior of individual components.

GAS DYNAMICS: An understanding of one-dimensional compressible flow principles, two-dimensional classical subsonic and supersonic aerodynamics, and an introduction to boundary-layer theory and heat transfer concepts.

INFORMATION PROCESSING: A knowledge of the applications and architecture of computers (data and signal processors) in air vehicles, including an understanding of microprocessor interfaces, and a knowledge of software design.

ENGINEERING MATHEMATICS: A demonstrated analytic ability in differential and integral calculus, ordinary and partial differential equations, operational calculus, complex functions, vector calculus, matrix algebra, numerical analysis, probability and statistics in experimental analysis, system safety, maintainability, reliability and survivability.

ELECTRICAL ENGINEERING: An understanding of electrical circuits, systems, and electronic devices; a knowledge of microwave, communications, and navigation principles; a basic knowledge of signal processing, antenna theory, and electro-optics, with applications in pulse and continuous wave radars, electrical apertures, conformal arrays, adaptive beamforming, and infra-red and laser technology.

SYSTEMS: An understanding of the inter-relationships of management decisions, systems engineering, design requirements, configuration management, integration and testing of avionics systems. This ability will include concerns for safety, reliability, maintainability and survivability.

JOINT AND MARITIME STRATEGIC PLANNING: A knowledge of Joint and Maritime Strategic Planning to include development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles and military forces, joint planning, and current issues in defense reorganization.

RESEARCH AND DEVELOPMENT: A knowledge of research and development programs applicable to current and future needs of Naval Aviation. An actual research and development experience will culminate in the publication of a thesis of both academic quality and relevance to Naval Aviation.

SPECIALIZATION OPTIONS

FLIGHT DYNAMICS: An understanding of rotary wing aerodynamics, performance and dynamics; flight test evaluation and engineering; and aeroelasticity principles.

INFORMATION PROCESSING: The ability to use modern computer methods in aeronautical engineering analysis; a knowledge of the applications of computers in naval vehicles; an understanding of data bus architectures, including fiber-optic concepts.

ELECTRICAL ENGINEERING: The ability to incorporate digital signal processing techniques to mission relevant applications such as radar systems, electronic warfare, antisubmarine warfare and electro-optic sensors.

SYSTEMS: An understanding of the analysis, design and development aspects of complete weapons systems, utilizing interdisciplinary engineering principles and modern systems, utilizing interdisciplinary engineering principles and modern systems case studies; an understanding of qualitative and quantitative risk assessment techniques, statistical decision-making, and reliability prediction as they are integrated into the Navy Safety Program; and an understanding of combat survivability technology and assessment methodology.

AIR-OCEAN SCIENCES PROGRAMS

Curricular Officer:
Timothy K. Cummings
CDR, USN
Code 35, Root Hall, Room 216
(408) 656-2044
DSN 878-2044

METEOROLOGY
CURRICULUM 372

This curriculum will provide qualified non-USN personnel with a sound understanding of the science of meteorology. The student will develop the technical expertise to assess and forecast the impact of atmospheric conditions on operations:

1) To understand the science of meteorological data and models.

2) To sample/measure, analyze and predict atmospheric conditions.

3) To operate and control data/information management systems.

4) To plan, conduct, interpret and present results of research activities.

REQUIREMENTS FOR ENTRY

This program is open to International Officers, officers from other services and DoD civilians. It is open to Oceanography (1800) officers of the U.S. Navy as a Ph.D. program.

A baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics is required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES

Meteorology is a seven-quarter course of study with preferred entry dates in April and October. A six-week technical refresher in calculus and physics is available preceding the entry dates. Also available during the refresher are short courses in FORTRAN programming and Introduction to Meteorology. For further information contact the Curricular Officer, CDR Timothy K. Cummings. Academic questions may be referred directly to the Academic Associate.

Curriculum 372
Academic Associate:
Roger T. Williams, Professor
Code MR/Wu, Root Hall, Room 247
(408)656-2296, DSN 878-2296

DEGREE

Master of Science in Meteorology.

TYPICAL COURSE OF STUDY

Quarter 1

MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Sciences
MA2049	(3-0)	Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/Laboratory
MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
MA3132	(4-0)	Partial Differential Equations and Integral Transforms

Quarter 3

MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorological Analysis/Lab
NS3252	(4-0)	Joint and Maritime Strategic Planning
MRXXXX	(3-0)	Meteorology Elective

Quarter 4

MR3234	(4-4)	Tropospheric and Stratospheric Meteorology/Lab
MR4900	(3-0)	Special Topics in Meteorology
MR/OC4323	(4-2)	Numerical Air and Ocean Modeling

Quarter 5

MR3252	(3-4)	Tropical Meteorology/Lab
MR0810	(0-0)	Thesis Research
MRXXXX	(4-0)	Meteorology Elective
MRXXXX	(4-0)	Meteorology Elective

Quarter 6

MR3262	(3-5)	Operational Atmospheric Prediction/Lab
MR0810	(0-0)	Thesis Research
MR4415	(3-0)	Atmospheric Turbulence
MRXXXX	(4-0)	Meteorology Elective

Quarter 7

MR0999	(2-0)	Thesis Presentation
MR0810	(0-0)	Thesis Research
MR4241	(3-0)	Mesoscale Meteorology
MRXXXX	(4-0)	Meteorology Elective

AIR-OCEAN SCIENCES
CURRICULUM 373

This curriculum in meteorology and oceanography involves approximately 120-quarter hours of classroom lectures, supplemented by an additional 35-quarter hours of laboratory exercises. This program is designed to provide the student with:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere.

2) The ability to observe, assimilate, analyze, interpret, and predict oceanic and atmospheric parameters and conditions using field experimentation, direct and remote sensing observational techniques, statistical analyses and numerical models.

3) A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics and electromagnetic/optical propagation.

4) An educationally significant oceanographic and meteorological experience at sea.

5) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.

6) A knowledge of Joint and Maritime Strategic Planning.

This education will enhance performance in all duties throughout a career, including operational billets, technical management assignments and policy making positions. Students will develop graduate-level technical ability based upon scientific principles, acquire diverse professional knowledge and develop analytical ability for practical problem solving.

REQUIREMENTS FOR ENTRY
This program is open to Oceanography (1800) Officers, officers from other services, International Officers and DoD Civilians.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Curriculum 460 is available for candidates who do not meet all admission requirements for direct entry.

AIR-OCEAN SCIENCE SUBSPECIALTY
Completion of this curriculum qualifies an officer as an Air-Ocean Subspecialist with a subspecialty code of XX47P. The Curriculum Sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:
Commanding Officer: Oceanographic Unit
Oceanographer: CV/LHD/LHA/LPH
Submarine Group Staff
Fleet Staff
CRUDESGRU Staff
OIC Naval Oceanography Command Detachment
NAVOCEANCOM Center/Facility
Defense Mapping Agency
Office of Naval Research

ENTRY DATES
Air-Ocean Sciences is a nine-quarter course of study with preferred entry dates in April and October. A six-week technical refresher in calculus and physics is available preceding these entry dates. Also available during the refresher are short courses in FORTRAN programming and Introduction to Meteorology. If further information is needed, contact the Curricular Officer. Academic questions may be referred directly to either of the Academic Associates.

Curriculum 373
Academic Associates:
Roger T. Williams, Professor
Code MR/Wu, Root Hall, Room 247
(408) 656-2296 DSN 878-2296

Roland W. Garwood, Jr., Professor
Code OC/Gd, Spanagel Hall, Room 308
(408) 656-3260 DSN 878-3260

DEGREE
Master of Science in Meteorology and Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
MR3480	(4-1)	Atmospheric Thermodynamics and Radiative Processes
MA2049	(3-0)	Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3321	(4 0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/ Laboratory
OC3230	(3-1)	Descriptive Physical Oceanography
MA3132	(4-0)	Partial Differential Equations and Integral Transforms

Quarter 3

MR4322	(4-0)	Dynamic Meteorology
MR3222	(4-3)	Meteorological Analysis
OC3420	(3-2)	Ocean Dynamics I
MR/OCXXXX	(3-0)	Focused Elective

Quarter 4

MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4211	(4-0)	Ocean Dynamics II
MR3234	(4-4)	Tropospheric and Stratospheric Analysis/Lab

Quarter 5

MR3252	(3-4)	Tropical Meteorology
MR/OC4413	(4-1)	Air-Sea Interaction
OC3260	(4-0)	Sound in the Ocean
MR/OCXXXX	(3-0)	Focused Elective

Quarter 6

MR/OC3212	(4-0)	Polar Meteorology/Oceanography
MR/OC4323	(4-2)	Numerical Air and Ocean Modelling
OC4267	(4-0)	Ocean Influences in Underwater Acoustics
MR/OC4900	(3-0)	Special Topics in Meteorology/Oceanography

Quarter 7

MR4416	(4-0)	Atmospheric Factors in EM and Optical Propagation
MR/OC0810	(0-0)	Thesis Research
OC4331	(4-0)	Mesoscale Ocean Variability
MR/OCXXXX	(4-0)	Focused Elective

Quarter 8

OC3266	(2-2)	Tactical Applications of Oceanography
MR/OC0810	(0-0)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategic Planning Elective
MR/OCXXXX	(4-0)	Elective

Quarter 9

MR/OC0810	(0-0)	Thesis Research
MR/OC0999	(0-0)	Thesis Presentation
MR3262	(3-5)	Operational Atmospheric Prediction
MR/OCXXXX	(4-0)	Elective

OPERATIONAL OCEANOGRAPHY CURRICULUM 374

This flexible oceanography curriculum involves approximately 100-quarter hours of classroom lectures, supplemented by an additional 20-quarter hours of laboratory exercises. This program is designed to provide the student with:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans.

2) An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational techniques, statistical analyses, and numerical models.

3) An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting Naval warfare with particular emphasis on ocean acoustics.

4) An educationally significant oceanographic experience at sea.

5) An oceanographic or meteorological research experience germane to Naval warfare culminating in a thesis of professional quality.

6) A knowledge of Joint Maritime Strategic Planning.

The Operational Oceanography Curriculum has a physical oceanography and ocean acoustics base and is a very flexible program. The student selects a warfare specialization area in antisubmarine warfare, amphibious warfare, mine warfare, anti-air warfare, strike warfare, and special warfare. This program is open to Unrestricted Line (1100, 1100, 1120, 1310, 1320) Officers, officers from other services, International Officers and DoD civilians.

REQUIREMENTS FOR ENTRY
A baccalaureate degree in the physical sciences, mathematics or engineering is desirable. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

OPERATIONAL OCEANOGRAPHY SUBSPECIALTY
Completion of this curriculum qualifies an officer as an Operational Oceanography Subspecialist with a subspecialty code of XX49P. The curriculum sponsor is OP-096, Oceanographer of the Navy.

Typical Jobs in this Subspecialty:
CV A.S.W. Module
CARGRU Staff
A.S.W. Operations Center
Navy Laboratories
Office of Naval Research
Patrol Wing Detachments
Naval Academy Instructor
Defense Mapping Agency
Naval Oceanographic Office

ENTRY DATES
Operational Oceanography is an eight-quarter course of study with preferred entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 374
Academic Associate:
Robert H. Bourke, Professor
Code OC/Bf, Spanagel Hall, Room 339B
(408) 656-3270, DSN 878-3270

DEGREE
Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1

MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
OC3230	(3-1)	Descriptive Physical Oceanography

MA2049	(3-0)	Vector Analysis
MA2121	(4-0)	Differential Equations

Quarter 2

MR/OC3150	(3-2)	Analysis of Air-Ocean Time Series
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
XXXX	(4-0)	Warfare Specialization Course

Quarter 3

OC3260	(4-0)	Sound in the Ocean
OC3240	(4-2)	Ocean Dynamics I
OC3120	(4-2)	Biogeochemical Processes in the Ocean
XXXX	(3-0)	Warfare Sepcialization Course

Quarter 4

OC4267	(4-0)	Ocean Influences in Underwater Acoustics
OC4211	(4-0)	Ocean Dynamics II
SS3525	(4-2)	Air-Ocean Remote Sensing for Inter-Disciplinary Curricula
XXXX	(3-0)	Warfare Specialization Course

Quarter 5

MR/OC4413	(4-0)	Air-Sea Interaction
OC4900	(3-0)	Special Topics in Oceanography
OC4331	(4-0)	Mesoscale Ocean Variability
XXXX	(4-0)	Warfare Specialization Course

Quarter 6

NS3252	(4-0)	Joint and Maritime Strategic Planning
OC0810	(0-0)	Thesis Research
OC3266	(3-2)	Tactical Applications of Oceanography
XXXX	(4-0)	Warfare Specialization Course

Quarter 7

OC0810	(0-0)	Thesis Research
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4213	(3-1)	Nearshore and Wave Processes
OCXXXX	(4-0)	Elective

Quarter 8

OC0810	(0-0)	Thesis Research
OC0999	(0-0)	Thesis Presentation
OC4220	(4-0)	Coastal Oceanography
OCXXXX	(4-0)	Elective

OCEANOGRAPHY
CURRICULUM 440

The Oceanography Curriculum provides students with a sound understanding of the science of oceanography. The student develops the technical expertise to provide and use oceanographic and acoustical data and models in support of all aspects of at-sea operations. The graduate will be able to:

1) Interpret and predict oceanic and air-ocean interface conditions.

2) Operate modern oceanographic data management, archival and communications systems.

3) Plan, conduct, interpret and present results of research activities.

This education further enhances performance in operational billets, technical management assignments and policy making positions. Students will develop sound, graduate-level technical ability based on scientific principles.

REQUIREMENTS FOR ENTRY
This program is open to International Officers, officers from other services and DoD civilians. It is open to Oceanography (1800) officers as a Ph.D. program.

A baccalaureate degree in the physical sciences, mathematics or engineering is required. Completion of mathematics through differential and integral calculus and one year of calculus-based college physics are required. An APC of 323 is required for direct entry. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements for direct entry.

ENTRY DATES
Oceanography is an eight-quarter course of study with entry dates in April and October. A six-week technical refresher in calculus and physics is available preceding these entry dates. Also available during the refresher is a short course in FORTRAN programming. If further information is needed, contact the Curricular Officer for this curriculum. Academic questions may be referred directly to the Academic Associate.

Curriculum 440
Academic Associate:
Roland W. Garwood, Professor
Code OC/Gd, Spanagel Hall, Room 308
(408)656-3260, DSN 878-3260

DEGREE
Master of Science in Physical Oceanography.

TYPICAL COURSE OF STUDY

Quarter 1		
MR/OC3140	(3-2)	Probability and Statistics for Air-Ocean Science
OC3230	(3-1)	Descriptive Physical Oceanography
MA2049	(3-0)	Vector Analysis
MA2121	(4-0)	Differential Equations
Quarter 2		
MR/OC3321	(4-0)	Air-Ocean Fluid Dynamics
MR/OC3522	(4-2)	Remote Sensing of the Atmosphere and Ocean/ Laboratory
MA3132	(4-0)	Partial Differential Equations and Integral Transforms
OCXXXX	(3-0)	Oceanography Elective
Quarter 3		
OC3260	(4-0)	Sound in the Ocean
OC3240	(3-2)	Ocean Dynamics I
OCXXXX	(3-0)	Oceanography Elective
OC3120	(4-2)	Biogeochemical Processes in the Ocean
Quarter 4		
OC4211	(4-0)	Ocean Dynamics II
OC3150	(3-2)	Analysis of Air-Ocean Time Series
OC4267	(4-0)	Ocean Influences and Prediction: Underwater Acoustics Elective
OCXXXX	(4-0)	Oceanography Elective

Quarter 5

MR/OC4413	(4-1)	Air-Sea Interaction
OC4900	(3-0)	Special Topics in Oceanography
MR/OC3570	(2-4)	Operational Oceanography and Meteorology
OC4331	(4-0)	Mesoscale Ocean Variability

Quarter 6

MR/OC3212	(4-0)	Polar Meteorology/Oceanography
MR/OC4323	(4-2)	Numerical Air and Ocean Modelling
MR/OC4414	(3-0)	Advanced Air-Sea Interaction
OC0810	(0-0)	Thesis Research

Quarter 7

OC4213	(3-1)	Nearshore and Wave Processes
OCXXXX	(4-0)	Oceanography Elective
OC0810	(0-0)	Thesis Research
OC4415	(3-0)	Ocean Turbulence

Quarter 8

OC4220	(3-2)	Coastal Oceanography
OCXXXX	(4-0)	Oceanography Elective
OC0810	(0-0)	Thesis Research
OC0999	(0-0)	Thesis Presentation

EDUCATIONAL SKILL REQUIREMENTS
AIR-OCEAN SCIENCE
CURRICULUM(373)

Officers completing this curriculum will have:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans and atmosphere;

2) The ability to observe, assimilate, analyze, interpret and predict oceanic and atmospheric parameters and conditions using field experimentation. Direct and remote sensing observational techniques, statistical analysis and numerical models;

3) A thorough understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare with particular emphasis on Ocean Acoustics and Electromagnetic/Optical Propagation;

4) A knowledge of Joint and Maritime Strategic Planning including development and execution of military strategy and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization;

5) An understanding of the fundamentals of mapping, charting and geodesy, precise time and time interval and astrometry;

6) And will successfully complete all Naval Postgraduate School requirements for the joint Masters Degree in Meteorology and Physical Oceanography.

NOTE: Thesis and sea experience ESRs have been deleted since they are already incorporated into the degree requirements.

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONAL OCEANOGRAPHY
CURRICULUM (374)

Officers completing this curriculum will develop:

1) A thorough understanding of the principles governing the physical and dynamic properties of the oceans;

2) An understanding of the analysis and prediction of oceanic and atmospheric parameters and conditions using direct and remote sensing observational techniques, statistical analyses, and numerical models;

3) An understanding of the effects of oceanic and atmospheric properties and conditions on weapon, sensor and platform performance while conducting and supporting naval warfare with particular emphasis on ocean acoustics;

4) An educationally significant oceanographic experience at sea;

5) An oceanographic or meteorological research experience germane to naval warfare, culminating in a thesis of professional quality;

6) An understanding of maritime strategic planning (applicable to all naval officers, when a suitable course is not available at the graduate institution, this requirement will be satisfied through other means, approved by NAVPGSCOL and the CNO (OP-096));

7) A thorough understanding of mapping, charting and geodesy (including marine geophysics, hydrography, geodesy, photogrammetry, cartography, electronic navigation, digital data techniques and image processing) for selected officers occupying designated MC&G billets (this ESR supports cases where acquiring graduate education or other formal training in MC&G may be warranted).

ANTISUBMARINE AND ELECTRONIC WARFARE PROGRAMS

Curricular Officer:
Rick Erazo
CDR, USN
Code 3A, Spanagel Hall
Room 304
(408) 656-2135/6
DSN 878-2135/6

ANTISUBMARINE WARFARE CURRICULUM 525

The ASW Curriculum educates officers in the engineering fundamentals, physical principles and analytical concepts that govern operational employment of ASW sensors and weapon systems and includes extensive breadth in the appropriate scientific and technical disciplines. This interdisciplinary program integrates mathematics, physics, acoustics, electrical engineering, oceanography, operations analysis, human factors, computer science and meteorology. The academic content divides naturally into four major areas: Electrical Engineering with emphasis on signal processing, Underwater Acoustics with emphasis on signal propagation and detection, Operations Analysis with emphasis on tactical application and decision analysis, and Air-Ocean Sciences with emphasis on the environmental factors affecting sound in the sea.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or equivalent, from a program with a calculus sequence and a calculus-based physics sequence that results in an APC of 323 is required for direct input. Courses in the physical sciences and engineering are desirable. An additional qualification for entry is that a selectee must have demonstrated strong professional performance in at least one ASW mission unit. Officers not meeting the academic requirements for direct input enter the program via one or two quarters of Engineering Science (Curriculum 460).

ANTISUBMARINE WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Antisubmarine Warfare Subspecialist with a subspecialty code of XX44P. The Curriculum Sponsor is OP-71, Antisubmarine Warfare Division.

Typical Jobs in this Subspecialty:
Naval Undersea Warfare Center
Naval Air Warfare Center
Program Executive Offices
Carrier Group Staffs
Naval Surface Warfare Development Group
Destroyer Squadron Staffs
Operational Test and Evaluation Force
Submarine Development Squadron Twelve
Patrol Wing Staffs
Naval Air Systems Command
OPNAV

ENTRY DATES

The ASW curriculum is an eight-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 525
Academic Associate:
James V. Sanders, Assoc. Professor
Code 33A, Spanagel Hall, Room 328
(408) 656-2116, DSN 878-2116

DEGREE
Requirements for the degree Master of Science in Applied Science are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations
PH2401	(3-0)	Introduction to the Sonar Equations
OC3230	(3-1)	Descriptive Physical Oceanography
PH2911	(3-2)	Introduction to Computational Physics

Quarter 2

NS3252	(4-0)	Joint and Maritime Strategic Planning
OS2103	(4-1)	Applied Probability for Systems Technology
PH2119	(4-2)	Oscillation and Waves
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations

Quarter 3

EO2740	(4-1)	Introduction to Linear Systems
OS3303	(4-1)	Computer Simulation
OS3604	(4-0)	Decision and Data Analysis
PH3402	(4-1)	Underwater Acoustics

Quarter 4

EO3720	(4-1)	Signal Processing Systems
OC4267	(4-3)	Ocean Influences and Predictions: Underwater Acoustics
OS3601	(4-0)	Search, Detection, and Localization Models
PH4403	(4-1)	Advanced Topics in Underwater Acoustics

Quarter 5

(First six weeks)		
MR2413	(3-1)	Meteorology for Antisubmarine Warfare
OS3402	(3-1)	Human Factors for Antisubmarine Warfare
(Last six weeks)		Experience Tour Off Campus

Quarter 6

EC4450	(4-1)	Sonar Systems Engineering
PH3479	(4-0)	Physics of Underwater Weapons
OC3266	(3-2)	Operational Acoustic Forecasting
ST0810	(0-0)	Thesis Research

Quarter 7

OA4607	(3-2)	Tactical Decisions for Antisubmarine Warfare
OS4601	(4-0)	Test and Evaluation
ST0810	(0-0)	Thesis Research

Quarter 8

PH3002	(4-0)	Non-Acoustic Sensor Systems
NS3152	(4-0)	Naval Warfare and the Threat Environment
OS3602	(4-0)	ASW Combat Analysis
ST0810	(0-0)	Thesis Research

ELECTRONIC WARFARE
CURRICULUM 595
This curriculum provides the services with officers thoroughly knowledgeable in the technical and operational aspects of the role of electronic warfare as a vital, integral part of

modern warfare. It is designed to provide an understanding of the principles underlying the broad field of electronic warfare and because of the electronic nature of modern sensor, weapon and command, control and communications systems, it seeks to develop in the officer a grasp of electronic, electrical and electromagnetic fundamentals, theory and techniques.

REQUIREMENTS FOR ENTRY

Students wishing to undertake studies in this curriculum require a baccalaureate degree with above-average grades and completion of mathematics courses through differential and integral calculus. Those lacking the background may matriculate via the Engineering Science Program (Curriculum 460). An APC of 324 is required for direct entry.

ELECTRONIC WARFARE SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Electronic Warfare Subspecialist with a code of XX46P. The Curriculum Sponsor is OP-76, Space and Electronic Warfare Division.

Typical Jobs in this Subspecialty:
Fleet and Group Staffs
Systems Commands
Naval Security Groups/Dets
U.S. Space Command
Operational Test and Evaluation Force
Joint Electronic Warfare Center
OPNAV

ENTRY DATE

This Electronic Warfare Curriculum is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

Curriculum 595
Academic Associate:
Jeff Knorr, Professor
Code EC/Ko, Spanagel Hall, Room 428
(408) 656-2815, DSN 878-2815

DEGREE

Requirements for the degree Master of Science in Systems Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

PH2911	(3-2)	Introduction to Computational Physics
MA2138	(5-0)	Multivariable Calculus and Vector Analysis
MA2121	(4-0)	Differential Equations
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics

Quarter 2

EO2170	(4-2)	Introduction to Electrical Engineering
OS2103	(4-1)	Applied Probability for Systems Technology
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO2760	(4-0)	Introduction to Fields and Waves

Quarter 3

EO2740	(4-1)	Introduction to Linear Systems
OS3604	(4-0)	Decision and Data Analysis
EO2770	(3-1)	Electromagnetic Engineering
PH2207	(4-0)	Fundamentals of Electro-Optics

Quarter 4

EO4760	(4-2)	Microwave Devices and Radar
PH3208	(4-1)	Electro-Optics Principles and Devices
EO3720	(4-0)	Signal Processing Systems
EO3760	(4-1)	Electromagnetic Radiation, Scattering and Propagation

Quarter 5

MR2416	(2-0)	Meteorology for Electronic Warfare
OS3003	(4-0)	Operations Research for Electronic Warfare
(Last Six Weeks)		Experience Tour Off Campus

Quarter 6

EO4780	(3-2)	Electronic Warfare Systems
EO4730	(3-1)	Electro-Optic Systems and Countermeasures
EC2820	(3-2)	Digital Logic Circuits
EW0810	(0-0)	Thesis Research

Quarter 7

EO3780	(3-2)	Electronic Warfare Computer Applications
OS4601	(4-0)	Operational Test and Evaluation
EW0810	(0-0)	Thesis Research
EW0810	(0-0)	Thesis Research

Quarter 8

EO3910	(4-0)	Communication and Countermeasures
NS3252	(4-0)	Joint and Maritime Strategic Planning
EWXXXX	(4-0)	Space and Electronic Warfare
EW0810	(0-0)	Thesis Research

ELECTRONIC WARFARE (INTERNATIONAL) CURRICULUM 596

The curriculum is modeled after Curriculum 595 and for the first three quarters exactly parallels the basic curriculum. In the second year, international students are channeled in courses similar in content to courses taught to U.S. students but without the classification level.

REQUIREMENTS FOR ENTRY

International students must meet the APC requirements and receive approval by the Director of Admissions at the Naval Postgraduate School. Actual quota assignment and invitational travel orders are approved and issued by the Office of the Chief of Naval Operations through the Foreign Military Assistance Division.

ENTRY DATES

This Electronic Warfare Curriculum is an eight-quarter course of study with an entry date in October. If further information is needed, contact the Academic Associate for this curriculum.

TYPICAL COURSE OF STUDY

Quarter 1

PH2911	(3-2)	Introduction to Computational Physics
MA2138	(5-0)	Multivariable Calculus and Vector Analysis

MA2121	(4-0)	Differential Equations
PH2203	(4-0)	Topics in Basic Physics: Waves and Optics

Quarter 2

EO2170	(4-2)	Introduction to Electrical Engineering
OS2103	(4-1)	Applied Probability for Systems Technology
MA3139	(4-0)	Fourier Analysis and Partial Differential Equations
EO2760	(4-0)	Introduction to Fields and Waves

Quarter 3

EO2740	(4-1)	Introduction to Linear Systems
OS3604	(4-0)	Decision and Data Analysis
EO2770	(3-1)	Electromagnetic Engineering
PH2207	(4-0)	Fundamentals of Electro-Optics

Quarter 4

EO3720	(4-0)	Signal Processing Systems
PH3208	(4-1)	Electro-Optic Principles and Devices
EC2820	(3-2)	Digital Logic Circuits
EC3600	(3-2)	Electromagnetic Radiation, Scattering and Propagation

Quarter 5

EC3610	(3-2)	Microwave Circuits
OS3003	(4-0)	Operations Research for Electronic Warfare
OS3303	(4-1)	Computer Simulation
MR2416	(2-0)	Meteorology for Electronic Warfare

Quarter 6

EC4620	(3-2)	Radar Systems
EC3620	(3-2)	Microwave Devices
PH4209	(3-2)	EO/IR Systems and Countermeasures
EW0810	(0-0)	Thesis Research

Quarter 7

EO3780	(3-2)	Electronic Warfare Computer Applications
OS4601	(4-0)	Test and Evaluation
EW0810	(0-0)	Thesis Research
EW0810	(0-0)	Thesis Research

Quarter 8

EC4690	(3-2)	Principles of Electronic Warfare Elective
EC3910	(4-0)	Communications and Countermeasures
EW0810	(0-0)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
ANTISUBMARINE WARFARE
CURRICULUM (525)

Education requirements for the officers of this multi-disciplinary curriculum consist of the following elements:

PHYSICS: The ability to understand the physical principles applicable to acoustic and non-acoustic ASW systems, and to ASW weapons systems.

ACOUSTICS: The ability to understand the acoustical phenomena affecting the design, performance, and operation of acoustic ASW systems.

OCEANOGRAPHY AND METEOROLOGY: The ability to understand the atmospheric and oceanographic processes influencing the performance and tactical use of ASW systems.

ELECTRICAL ENGINEERING: The ability to understand the principles of signal processing as they apply to ASW systems.

OPERATIONS RESEARCH AND SYSTEMS TECHNOLOGY: The ability to understand; computer simulation and war-gaming models for ASW systems, the effect of human factors in the design and operation of ASW systems, the principles and techniques of C3 for ASW systems, the acquisition process and principles of test and evaluation of ASW systems, the design of tactical decision aids for ASW systems.

JOINT AND MARITIME STRATEGIC PLANNING: The ability to understand; the fundamentals of threat analysis and the Navy's function in national security policy, the development and execution of military strategy, the effects of technical developments on warfare, the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

PROBLEM SOLVING AND PRACTICAL APPLICABILITY: The ability to recognize scientific and engineering advances of potential value to antisubmarine warfare, to exercise skills in problem formulation, criteria specification, data collection and experimentation, analysis and evaluation, and presentation of results.

EDUCATIONAL SKILL REQUIREMENTS
ELECTRONIC WARFARE
CURRICULUM (595)

PHYSICS: The ability to understand the physical principles of transmission, propagation, reception, and processing of electro-optic signals, infrared signals, and radio frequency signals.

METEOROLOGY: The ability to understand the atmospheric processes influencing the performance and tactical use of EW systems.

ELECTRICAL ENGINEERING: The ability to understand the principles of signal processing as they apply to EW systems.

ELECTRONIC WARFARE: The ability to understand the tactical use of real-time systems, to understand the integration of EW with weapons systems and C3, to understand the role of EW in warfare areas, to translate technological factors into operational capability, to perform assessments of warfare operational capabilities, to understand computer simulation and war-gaming models for EW, to understand the principles and techniques of C3 for EW systems, to understand the acquisition process and principles of test and evaluation of EW systems, to perform an assessment of technical uncertainty, to develop models for simulation, gaming, and tactical use and to define operational effectiveness criteria.

JOINT AND MARITIME STRATEGIC PLANNING: The ability to understand the fundamentals of threat analysis and the Navy's function in national security policy, the development and execution of military strategy and the effects of technical developments on warfare, the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

PROBLEM SOLVING AND PRACTICAL APPLICABILITY: The ability to recognize scientific and engineering advances of potential value to electronic warfare and to exercise skills in problem formulation, criteria specification, data collection and experimentation, analysis and evaluation, and presentation of results.

COMBAT SYSTEMS PROGRAMS

Curricular Officer:
L. Athow
CDR, USN
Code 33, Spanagel Hall
Room 328
(408) 656-2116/7 DSN 878-2116/7

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY CURRICULUM 533

This program, which replaces the four Weapons Systems Engineering Programs, is designed to meet the needs of the military services for an officer having a broad-based advanced technical education applicable to combat systems design, development, test and evaluation, acquisition, operation, and support. Included in the core are courses on electromagnetic radiation, signal processing, optoelectronics, servo and computer control systems, explosives and warheads, fluid dynamics of weapons, engineering materials, combat simulation, quantum detection devices, detection and engagement elements, combat systems integration, and computers for advanced combat systems. Additionally, the officer will take a sequence of five or more courses in one of the following concentration areas: electromagnetic sensors systems, nuclear and directed energy weapons and effects, underwater acoustic systems, or an engineering area related to combat systems. The officer will also conduct thesis research on a specific technical problem. The curriculum includes survey courses in areas not covered by the officer's concentration.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based basic physics sequence are required for direct input. Courses in the physical sciences and engineering are highly desirable. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science (460) Curriculum discussed elsewhere in this catalog. An APC of 323 is required.

COMBAT SYSTEMS SCIENCES AND TECHNOLOGY SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Combat Systems Sciences and Technology Subspecialist with a subspecialty code of XX6P. The curriculum sponsors are Naval Sea Systems Command, Test and Evaluation and Technology Requirements (OPO91B).

Typical Jobs in this Subspecialty:
NTDS-CIC: FLTCOMBDSSA, San Diego, CA
Warfare Systems Officer: SPAWAR OPSUPFLD 6
Weapons Instructor: Naval Academy, Annapolis, MD
Staff Readiness (Weapons): COMCRUDESGRU 1, 2, 3, 5, 8, 12
Testing Officer: COMOPTEVFOR
Weapons Instructor: SWOSCOLCOM
Weapons Department Head: Naval Academy, Annapolis, MD
Research Associate: Lawrence Livermore Laboratory
Physics Instructor: Naval Academy, Annapolis, MD
Research Associate: Los Alamos National Laboratory
Electro-Optics Project Officer: Naval Ocean Systems Center, San Diego CA
Testing Officer: COMOPTEVFOR
Research Officer: Naval Research Laboratory
Project Management: Naval Sea Systems Command

Test Manager: Defense Nuclear Agency (DNA)
Research and Development Coordinator: Defense Nuclear Agency (DNA)
Physicist: Defense Nuclear Agency (DNA)Tactical Nuclear Weapons/Plans: CINCLANT
Test Officer/Programs Officer: DNA, Kirkland AFB
Navy Research Officer: Los Alamos National Laboratory
Navy Research Officer: Lawrence Livermore Laboratory
Nuclear Effects Officer/Nucleonics Officer: SPAWARSYSCOM
Nuclear Physicist: DNA, Los Alamos
Instructor: Nuclear Weapons Training Group - Atlantic
Instructor: Naval Postgraduate School, Monterey, CA
Training Officer: PDW-124 (Undersea Surveillance)
Staff: Commander 7th Fleet
Staff: COMNAVSURFLANT
Test and Evaluation Officer: OPTEVFOR
Strategic Systems Project Officer: Director of SSPO
Staff Antisubmarine Warfare: NAVSEASYSCOM
Research and Development Project Officer: Office of Secretary of Defense

ENTRY DATES
Combat Systems Sciences and Technology is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 533
Academic Associate:
James V. Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 146B
(408) 656-2931/2116, DSN 878-2931/2116

DEGREE
Requirements for the degree Master of Science in Applied Physics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program. On a case-by-case basis, some students, depending on background, may earn a Master of Science in Physics, Computer Science or one of the engineering disciplines.

TYPICAL COURSE OF STUDY

Quarter 1

MA1118	(5-2)	Multi-variable Calculus
MA2121	(4-0)	Differential Equations
SE2012	(2-3)	Applied Physics Lab I: Fundamentals
MS2201	(3-2)	Materials Science & Engineering

Quarter 2

PH2170	(4-0)	Analytical Mechanics
PH2990	(4-0)	Physics of Vibrations & Waves I
SE2013	(2-3)	Applied Physics Lab II: Analog Techniques
MS3202	(3-2)	Engineering Materials

Quarter 3

PH2351	(4-1)	Electromagnetism
PH3991	(4-0)	Physics of Vibration & Waves II
SE2014	(2-3)	Applied Physics Lab III: Digital Techniques
PH2911	(3-2)	Introduction to Computational Physics

Quarter 4

PH3352	(4-0)	Electromagnetic Waves
PH3292	(3-2)	Optics Optoelectronics
SE3015	(2-3)	Applied Physics Lab IV: Systems Control
PH3171	(4-0)	Explosives & Warheads

Quarter 5

PH3652	(4-1)	Foundation of Quantum Devices
PH4911	(3-2)	Simulation of Physical & Weapon Systems
PH3172	(4-0)	Fluid Dynamics of Weapons
		Concentration Course

Quarter 6

PH3653	(4-0)	Quantum Devices
TS3003	(4-0)	Naval Combat Systems
PH3400	(4-0)	Survey of Underwater Acoustics for Naval Applications* Thesis Research

Quarter 7

NS3252	(4-0)	Joint & Maritime Strategic Planning
TS3005	(4-0)	Combat Sytstems
PH3400	(4-0)	Survey of Electro-Optic Devices*
		Concentration Course or Thesis Research

Quarter 8

EC4980	(3-0)	Computer Architecture for Weapons Systems
PH3800	(4-0)	Survey of Nuclear & Directed Energy Weapons Effects*
		Concentration Course
		Thesis

Quarter 9

Concentration Course
Concentration Course
Thesis Research
Thesis Research

Concentration Area and Representative Courses

Electromagnetic Sensor Systems:
PH3782 Thermodynamics & Statistical Physics; Advanced Electromagnetic Propagation*; Sensors and Devices*; Advanced Concepts in Target Surveillance, Acquisition, & Engagement*; PH4253 Sensors, Signal & Systems; PH4254 Thermal Imaging & Surveillance Systems; PH4054 Directed Energy Weapon Systems; PH4055 Free Electron Lasers; PH4161 Plasma Physics I; Space Environment*.

Nuclear and Directed Energy Weapons and Effects:
PH3855 Nuclear Physics; PH4161 Plasma Physics I; PH4054 Directed Energy Weapon Systems; Effects of radiation & EMP on Electronic Systems*; Nuclear Weapons Survivability & Lethality*; PH4857 Radiation Hydrodynamic Transport Theory.

Underwater Acoustic Systems:
PH3451 Fundamental Acoustics; PH3452 Underwater Acoustics; PH4454 Transducer Theory and Design; PH3458 Noise, Shock & Vibration Control; PH4455 Sound Propagation in the Ocean; Sonar Signal Processing*.

* Course description not available at time of publication.

EDUCATIONAL SKILL REQUIREMENTS
COMBAT SYSTEMS SCIENCE AND TECHNOLOGY
CURRICULUM (533)

MATHEMATICS, SCIENCE AND ENGINEERING FUNDAMENTALS: A solid foundation in mathematics, physics and engineering to support the theoretical and experimental aspects of the technical courses in the curriculum.

SCIENTIFIC AND ENGINEERING PRINCIPLES: Principles necessary to understand the elements of combat systems;

a) Acoustic and electromagnetic propagation, physics of solid state, electro optic, and quantum devices, principles of radar and sonar systems, signal analysis, decision and theory.

b) Communication systems, fiber optics, open architectures and their implications on integration of computing resources in advanced systems, and automatic control systems.

c) Fluid dynamics of subsonic and supersonic weapons, and their effects, counter measures and deception warheads techniques.

d) Combat systems simulation and testing including sufficient probability and statistics theory to appreciate the limits of simulation.

COMBAT SYSTEMS ENGINEERING: An understanding of the principles of design, development, improvement and logistics engineering; and, the importance of technical and economic tradeoffs.

MATERIALS SCIENCE: A familiarity of the concepts of materials science sufficient for an understanding of the mechanical, electrical, and thermal properties of materials.

JOINT AND MARITIME STRATEGIC PLANNING: Development and execution of military strategy and the effects of technical developments on warfare; formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

GRADUATE CONCENTRATION: A concentration of several graduate level courses in a technical field within the general area of combat systems. The knowledge required for an approved concentration is;

A. ELECTROMAGNETIC SYSTEMS

1) Statistical physics
2) Electromagnetic Propagation in homogeneous and random media
3) Sensors for detecting Electromagnetic radiations
4) Concepts of target surveillance, acquisition, and engagement

B. NUCLEAR & DIRECTED ENERGY WEAPONS & EFFECTS

1) Nuclear and statistical physics
2) Nuclear weapons and their effects

3) Effects of radiation & EMP on electronic systems
4) Principles of directed energy weapons systems
5) Survivability & lethality considerations for nuclear and directed energy weapons.

C. UNDERWATER ACOUSTIC SYSTEMS

1) Acoustical theories, mechanical vibration, wave propagation in the ocean, scattering, fluctuations, and boundary interactions; transducer theory and design and array theory.
2) Active and passive acoustic signal processing including adaptive techniques.
3) Acoustic influences of oceanographic phenomena including boundary characteristics, ambient noise, sound speed profiles, fronts, and eddies.

D. ENGINEERING DISCIPLINE

1) A series of at least six graduate-level courses in an area related to combat systems in the disciplines of either Electrical Engineering, Mechanical Engineering, Aeronautical Engineering, Computer Science, or Physics. This series must be approved by the Curricular Officer.

THESIS: Ability to recognize scientific and engineering advancements of potential value to the Navy, to formulate a research problem, to perform the necessary research, and to report the results.

COMPUTER TECHNOLOGY PROGRAMS

Curricular Officer:
Thomas J. Hoskins
CDR, USN
Code 37
Spanagel Hall, Room 401
(408) 656-2174/5
DSN 878-2174/5

COMPUTER SCIENCE
CURRICULUM 368

The Computer Science curriculum is designed to provide the officer with the technical knowledge and skills necessary to specify, evaluate and manage computer system design; to provide technical guidance in applications ranging from data processing to tactical embedded systems; to educate the officer in the analysis and design methodologies appropriate for hardware, software and firmware; and to provide the officer with practical experience in applying modern computer equipment and research techniques to solve military problems.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or the equivalent, with above-average grades in mathematics, (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination), indicate a capability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

COMPUTER SCIENCE SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Computer Science Subspecialist with a subspecialty code of XX91P. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:
Preoperational Test and Evaluation, Space and Electronic Warfare Systems Command, Washington, DC
Computer Systems Analyst, COMNAVSECGRU, Washington, DC
ADP Systems Director, Naval Security Group Honolulu, HI
Database Manager, TACTRAGRUPAC, San Diego, CA
Project Officer, BUPERS, Washington, DC

ENTRY DATES

Computer Science is an eight-quarter course of study with entry dates in April and October. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 368
Academic Associate:
Michael Zyda, Associate Professor
Code CS/Zk, Spanagel Hall, Room 516
(408) 656-2305, DSN 878-2305
Fax: (408) 656-2814, DSN 878-2814

DEGREE

Requirements for the degree Master of Science in Computer Science are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1		
CS2970	(4-1)	Structured Programming in ADA
CS3010	(4-0)	Computing Devices and Systems
MA2025	(4-1)	Bridge to Advanced Mathematics
OS3001	(4-0)	Operations Research for Computer Scientists
Quarter 2		
CS3111	(4-0)	Principles of Programming Languages
CS3200	(3-2)	Computer Architecture
CS3300	(3-1)	Data Structures
MA3026	(5-0)	Discrete Mathematics with Applications
Quarter 3		
CS3310	(4-0)	Artificial Intelligence
CS3320	(3-1)	Database Systems
CS3450	(3-1)	Systems Software Design
CS3460	(3-1)	Software Methodology
Quarter 4		
CS3502	(4-0)	Computer Communications and Networks
CS3601	(4-0)	Theory of Formal Languages and Automata
CS4900	(0-2)	Research Seminar in Computer Science
----------	(4-0)	Track Requirement*
----------	(4-0)	Track Requirement*
Quarter 5		
CS4112	(4-0)	Operating Systems
CS4202	(3-2)	Computer Graphics
CS4601	(4-0)	Computer Security
----------	(4-0)	Track Requirement*
Quarter 6		
CS3650	(4-0)	Design and Analysis of Algorithms
----------	(4-0)	Track Requirement*
----------	(4-0)	Track Requirement*
CS0810	(0-0)	Thesis Research
Quarter 7		
----------	(4-0)	Track Requirement*
----------	(4-0)	Track Requirement*
NS3252	(4-0)	Joint and Maritime Strategic Planning
CS0810	(0-0)	Thesis Research
Quarter 8		
----------	(4-0)	Track Requirement*
----------	(4-0)	Track Requirement*
CS0810	(0-0)	Thesis Research

*NOTE: Track Requirement courses will be determined by the selection of one of the following specialization track options: Artificial Intelligence and Robotics, Computer Graphics and Visual Simulation, Database and DataEngineering, Software Engineering or Computer Systems and Architectures.

The objectives of the Artificial Intelligence and Robotics Track are to present current state of knowledge regarding advanced symbolic computation, to develop skills in the use of AI languages and expert system shells and to present fundamental scientific/engineering knowledge in robotics for military applications.

The Computer Graphics and Visual Simulation Track is designed to provide an understanding of the methodologies and techniques required in real-time, three-dimensional, interactive, visual simulations for military applications.

The objective of the Database and Data Engineering Track is to provide an understanding of data retrieval and processing using the best available database system management and operating system techniques and concepts.

The purposes of the Software Engineering Track are to provide knowledge of all aspects of software development and to develop skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques, with particular emphasis on the use of Ada.

The Computer Systems and Architectures Track is designed to provide knowledge of computer architecture and system software for real-time and multi-computer systems with emphasis on military applications to embedded computers and secure systems.

INFORMATION TECHNOLOGY MANAGEMENT CURRICULUM 370

This new curriculum is the result of combining the former Computer Systems Management (#367) and Telecommunications Systems Management (#620) curricula.

This program provides officers with the knowledge of information systems technology to include computer and telecommunications systems, software engineering, networked and distributed applications, database management systems and decision support systems in the military services. Students will also gain proficiency in information systems, economics and management necessary for the critical management decisions needed in the development and utilization of complex and evolving computer-based military systems.

Information Technology Management is an interdisciplinary, graduate-level master's program integrating mathematics, accounting, economics, statistics, computer science, information systems, electrical engineering, and management disciplines.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or the equivalent, with above-average grades in mathematics (including differential and integral calculus) resulting in an APC of at least 325 is required for direct entry. Students lacking these quantitative prerequisites may be acceptable for the program, through a six or twelve week refresher, providing their undergraduate records and/or other indicators of success, such as the GRE (Graduate Record Examination) or GMAT (Graduate Management Admission Test), indicate a capability for graduate level work. While previous computer, communications or information systems experience is certainly helpful, it is not essential.

INFORMATION TECHNOLOGY MANAGEMENT SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Information Technology Management Subspecialist with a subspecialty code of XX89P. The Curriculum Sponsor is Commander, Naval Computer and Telecommunications Command.

Typical Jobs in this Subspecialty:

Computer Systems Analyst, Naval Computer and Telecommunications Station, Washington, DC
ADP Programs (SNAP), NAVMASSO, San Diego, CA
Research Branch, Naval War College, Newport, RI
Electronics Equipment Research, NOSC, San Diego, CA

ADP Plans Officer, Naval Computer and Telecommunications Station, Pearl Harbor, HI
Computer Systems Analyst, Naval Computer and Telecommunications Station, New Orleans, LA

ENTRY DATES
Information Technology Management is an eight-quarter course of study with entry dates in April and October. Those requiring the six or twelve week refresher will begin study prior to those entry dates. If further information is needed contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 370
Academic Associate:
Tung X. Bui, Associate Professor
Code AS/Bd, Ingersoll Hall, Room 312
(408) 656-2630, DSN 878-2630
Bitnet: 3867P@NAVPGS
Fax:(408) 656-3407, DSN 878-3407

DEGREE
Requirements for the degree Master of Science in Information Technology Management are met as a milestone en route to satisfying the Educational Skill Requirements established by the sponsor for the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CS2970	(4-1)	Structured Programming in Ada
IS2000	(3-1)	Introduction to Computer Management
MN2155	(4-0)	Accounting for Management
OS3101	(4-0)	Statistical Analysis for Management

Quarter 2

CS3030	(4-0)	Computer Architecture and Operating Systems
MA1248	(4-1)	Selected Topics in Applied Mathematics
MN3105	(4-0)	Organization and Management
OS3004	(5-0)	Operations Research for Computer Systems Managers

Quarter 3

EO2710	(4-2)	Comm Systems I: Analog Signals and Systems
IS3170	(4-0)	Economic Evaluation of Information Systems I
IS4183	(4-1)	Applications of Database Management Systems
IS4200	(4-0)	Systems Analysis and Design

Quarter 4

EO2750	(3-1)	Comm Systems II: Digital Signals and Systems
IS3020	(4-0)	Software Design
IS3171	(4-0)	Economic Evaluation of Information Systems II
IS4185	(4-1)	Decision Support and Expert Systems

Quarter 5

CM3112	(4-0)	Navy Telecommunications Systems
EO3750	(3-1)	Communications Systems Analysis
IS3502	(4-0)	Computer Networks: Wide Area/Local Area
IS4300	(4-0)	Software Engineering and Management

Quarter 6

IS4502	(4-0)	Telecommunications Networks
MN4125	(4-0)	Managing Planned Change in Complex Organizations

NS3252	(4-0)	Joint and Maritime Strategic Planning
IS0810	(0-0)	Thesis Research

Quarter 7

CS4601	(4-0)	Computer Security
MN3307	(4-0)	ADP Acquisition
MN3154	(4-0)	Financial Management in the Armed Forces
IS0810	(0-0)	Thesis Research

Quarter 8

IS4182	(4-0)	Information Systems Management
IS0810	(0-0)	Thesis Research
---------	(4-0)	Elective Course (see note)

NOTE: Students with a strong education and background in any of the above topics can request validation of those courses and thereby avail themselves of additional elective courses. Typical elective courses include, but are not limited to:

CS3310	Artificial Intelligence
CS4202	Computer Graphics
IS3000	Distributed Computer Systems
IS3100	Analysis of Microcomputers and Microprocessors
IS3220	Computer Center Management
IS3503	Microcomputer Networks
IS4184	Information Resource Management in DoN/DoD
IS4186	Introduction to Knowledge-Based Systems and Artificial Intelligence
IS4800	Directed Study in Advanced Information Systems
MN3374	Production Management: a TQM/L Perspective
MN4105	Management Policy
MN4151	Internal Control and Auditing
MN4900	Readings in Administrative Science
MR2419	Atmospheric Factors in C3
OS3404	Man-Machine Interaction

EDUCATIONAL SKILL REQUIREMENTS
COMPUTER SCIENCE
CURRICULUM (368)

All officers with advanced degree education in Computer Science must possess skills and competencies in software engineering and design methodologies, computer system design and computer architecture. The skills and competencies are detailed below.

JOINT AND MARITIME STRATEGIC PLANNING: Joint and Maritime Strategic Planning to include development and execution of military strategy and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

SOFTWARE ENGINEERING: The officer must have a thorough knowledge of software engineering to include:

a) An understanding of the software development process, including specification of requirements, design, implementation, testing, and maintenance;

b) The ability to plan and implement a major programming project and develop the appropriate documentation, and;

c) The ability to incorporate and enforce modern software engineering techniques in system design.

SOFTWARE TECHNOLOGY: The officer must have a thorough knowledge of software technology to include:

a) The formal definition of programming languages covering specifications of syntax and semantics, properties of block structured languages, programming techniques and evaluation of languages;

b) The relations that hold among the elements of data involved in problems, the structure of storage media and machines, the methods useful in representing structured data in storage, and techniques of operating upon data structures;

c) Operating systems used in various environments relative to addressing techniques, memory management, file system design and management, system accountability, and security;

d) Design and implementation of database systems including the hierarchy, network and relational models, and the language extensions required to support such systems;

e) Computer graphics covering human-computer interaction and methods for computer-assisted problem solving;

f) Artificial intelligence techniques including heuristic search, artificial intelligence languages, knowledge representation, expert systems, and means-end analysis, and;

g) Formal methods systems for the design and analysis of software.

COMPUTER SYSTEMS DESIGN: The officer must have a thorough knowledge of computer system design to include:

a. System analysis and design theory encompassing the basics of analysis, design, and testing;

b. Empirical and analytical methods for determining the efficiency and performance of computer systems;

c. An understanding of the design issues of hardware/software compatibility, operating systems compatibility, and information systems requirements;

d. Computer-science theory relevant to the capabilities and limitations of hardware and software systems, and;

e. Computer security of hardware systems, software systems, and networks.

COMPUTER ARCHITECTURE: The officer must have a thorough knowledge of computer architecture to include:

a. Basic components of computer systems and their patterns of configuration and communication covering the range of large scale mainframes to microcomputers, and;

b. The organization, logic design, and components of digital computing systems relating to multi-processing, parallel processing, distributed processing, and networking.

PROBLEM SOLVING AND REAL WORLD APPLICABILITY: The officer shall possess skills that permit a realistic perspective on problem solving and provide an appreciation of the difficulty and power of applying theory to the real world in a Navy organization. This includes:

a. Completing a significant project applying academic skills outside of the classroom, and;

b. Exercising skills in problem formulation, criteria specification, analysis and evaluation and presentation of results.

EDUCATIONAL SKILL REQUIREMENTS
INFORMATION TECHNOLOGY
CURRICULUM (370)

All officers with advanced degree education in Information Technology Management must be prepared for assignment as senior information systems/communications subspecialists in appropriate billets afloat or ashore with the Navy and joint staffs. They must possess the following proficiency and capacities:

JOINT AND MARITIME STRATEGIC PLANNING: Joint and Maritime Strategic Planning to include development and execution of military strategy and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

INFORMATION SYSTEMS TECHNOLOGY: The officer must have a thorough knowledge of information systems technology to include:

a) Major components of computer systems: Basic components of computer systems including central processing units, input/output devices, storage devices, telecommunication devices and programming languages.

b) Data communications systems and networks: Basic components of wide and local area network hardware systems, physical layer interfaces and protocols, analog and digital transmission facilities, communications software, network management and control, and computer security. Micro-mainframe connectivity. Distributed computer systems.

c) Software engineering: Methodologies for the analysis, design, development, prototype creation, testing, implementation and maintenance of information systems. Productivity analysis and software cost estimation and planning. Man-machine interfaces and system ergonomics.

d) Database management systems: Database technologies and technical and administrative issues involved in the design, implementation and maintenance of database management systems.

e) Decision support and expert systems: Problem identification, formulation, and design of computer systems to support decision making. Application of artificial intelligence technology to preserve perishable expertise and enhance distributed expertise. Understanding the design of executive information systems, office automation, group decision support systems and crisis management systems, and their potential impacts on organizations and missions.

INFORMATION SYSTEMS ECONOMICS AND MANAGEMENT: The officer must master the following analytical methods to effectively manage information system assets:

a) Basic managerial concepts: Decision-making theory, micro- and macroeconomics, operations analysis, financial management, organizational development, and research methodologies.

b) Economic evaluation of information systems: cost benefit analysis, cost effectiveness analysis, and multiple attribute analysis of information systems. Selection, evaluation, acquisition, installation and effective utilization of information systems hardware and software. Risk assessment of computer applications.

c) Systems analysis and design: Information systems feasibility studies and life cycle management including fact-finding techniques for determining system requirements and specifications, system performance evaluation, conversion and maintenance of software and the post-implementation evaluation and security analysis of information systems.

d) Management of information systems: Information systems facilities planning, production planning and control, requirements determination of information systems personnel, human resource management, budgeting and financial control of computer centers, design of effective organization structure and information systems, and control and security policies.

e) Changing computer economics and management: Evaluation of potential impacts of new technology on information systems planning and development and on organization strategy. Appraisal of evolving responsibilities of information systems managers.

MILITARY APPLICATIONS: The officer must be able to combine analytical methods and technical expertise with operational experience for effective military applications to include:

a) DoD decision making process on information systems: DoD, DoN, OMB, and congressional decision making on information systems matters.

b) Acquisition Management: Acquisition policies and procedures of the DoD, including planning, programming and budgeting system.

c) DoD telecommunications: Architectures and specifications of Navy, DoD and civilian computer and telecommunications networks and services, including the Defense Communication System (DCS), Navy fleet communications system, including satellite communications, and the Navy Telecommunications System (NTS).

INDEPENDENT RESEARCH: The officer must be able to conduct and report independent research in information technology and its management to include problem formulation, decision criteria specification, decision modeling, data collection and experimentation, analysis, evaluation, and presentation of results.

ELECTRONICS AND COMMUNICATIONS PROGRAMS

Curricular Officer:
Rondel G. Reynolds
CDR, USN
Code 32, Spanagel Hall
Room 404
(408) 656-2056
DSN 878-2056

ELECTRONIC SYSTEMS ENGINEERING CURRICULUM 590

This curriculum is designed to educate officers in current electronics technology and its application to modern naval warfare. It establishes a broad background of basic engineering knowledge, leading to selected advanced studies in electronic systems, ship/ weapon control systems, and communication/ information processing applicability. It will enhance individual performance in all duties through a naval career, including operational billets, technical management assignments and policy making positions, thereby preparing the officer for progressively increased responsibility including command, both ashore and afloat.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in engineering or the physical sciences is desired. Differential and integral calculus, one year of calculus- based college physics and at least one semester of college chemistry are required. The Engineering Science Program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. Prior to undertaking the program, or as a part of the program, each officer will have earned the equivalent of an accredited BSEE. An APC of 323 is required for direct entry.

ELECTRONICS AND COMMUNICATIONS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Engineering Electronics Subspecialist with a subspecialty code XX55. The curriculum sponsor is Space and Naval Warfare Systems Command.

Typical Jobs in this Subspecialty:
Instructor: Naval Academy, Annapolis, MD
Executive Officer: SPAWARHDQTRS
Operations Test and Evaluation: COMOPTEVFOR
Electronics Maintenance Officer: USS NIMITZ CVN 68
Executive Officer: NEEACT PAC, Pearl Harbor, HI
Electronics P and P: CINCLANTFLT
Electronics Maintenance Officer: USS BLUE RIDGE LCC 19
Project Officer: Warfare Systems Architecture and Engineering, SPAWARHDQTR

ENTRY DATES

Electronic Systems Engineering is a eight-quarter course of study with entry dates in every quarter. A six-quarter program is availble for officers with an ABET accredited BSEE degree on a case-by-case basis. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 590
Academic Associate:
Clark Robertson, Professor
Code EC/Rc, S-414A
(408) 656-2383, DSN 878-2383

DEGREE

Requirements for the degree Master of Science in Electrical Engineering are met en route to satisfying the Educational Skill Requirements.

TYPICAL COURSE OF STUDY

COMPUTER SYSTEMS OPTION

Quarter 1

EC2100	(3-2)	Circuit Analysis I
EC2820	(3-2)	Digital Logic Circuits
MA1118	(5-2)	Multivariable Calculus
CS2970	(4-1)	Structured Programming with Ada

Quarter 2

EC2110	(3-2)	Circuit Analysis II
EC2200	(3-3)	Electronics Engineering I
EC2400	(3-0)	Discrete Systems
EC2800	(3-2)	Intro to Microprocessors

Quarter 3

ECXXXX		BSEE Elective I
EC2210	(3-2)	Electronics Engineering II
EC2410	(3-0)	Fourier Analysis of Signals and Systems
EC3800	(3-2)	Microprocess Systems

Quarter 4

ECXXXX		BSEE Elective II
MA3132	(4-1)	Numerical Analysis
EC3500	(4-0)	Analysis of Random Signals
EC2420	(3-0)	Systems Theory

Quarter 5

NS3252	(4-0)	Joint Strategy
EC2220	(2-4)	Electronics Engineering III
EC3820	(3-1)	Computer Systems
ECXXXX		BSEE Elective III

Quarter 6

EC3550	(3-1)	Fiber Optics
EC4830	(3-1)	Digital Computer Design Methodology
EC3830	(3-2)	Digital Computer Design
EC0810	(0-0)	Thesis Research

Quarter 7

ECXXXX		MSEE Elective I
EC4850	(3-0)	Computer Comms
EC0810	(0-0)	Thesis Research
EC0810	(0-0)	Thesis Research

Quarter 8

ECXXXX		MSEE Elective II
EC4800	(3-0)	Advanced topics in Computers
EC4870	(3-2)	VLSI Systems Design
EC0810	(0-0)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
ELECTRONIC SYSTEMS ENGINEERING
CURRICULUM (590)

JOINT AND MARITIME STRATEGIC PLANNING: The officer will have a graduate-level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

MATHEMATICS: The officer will have a thorough knowledge of mathematical tools which are intrinsic to electrical and computer engineering, including but not limited to differential equations, vector analysis, linear algebra, probability, numerical analysis, and Fourier and Laplace methods.

ENGINEERING SCIENCE: To acquire the background necessary to meet the other military education requirements, the officer will achieve proficiency in modern physics, electro-magnetics, electronic devices and circuits, and in other appropriate fields such as dynamics, fluid mechanics and thermo dynamics, which provide the requisite breadth to a military engineering education.

COMPUTERS: The officer will have a sound understanding of programming languages including ADA, digital logic circuits, microprocessor applications and the integration of software and hardware into systems.

ELECTRONIC AND ELECTRICAL ENGINEERING: In order to provide officers skilled in the application of electronic systems to military needs, the officer will have competence in the broad area of electrical engineering including circuits, electronics, fiber optics and systems analysis. The officer will select elective courses to obtain breadth in his/her understanding of electronic systems.

Additionally, to achieve depth of understanding, the officer shall specialize in one of the following areas:

a) communication systems
b) guidance, navigation, and control systems
c) radar, electro-optic, and electronic warfare systems
d) computer systems
e) signal processing systems
f) power engineering

SYSTEM DESIGN AND SYNTHESIS: The officer will have a sound understanding of engineering principles utilized in engineering system design including establishment of system-related objectives and criteria.

CONDUCTING AND REPORTING INDEPENDENT INVESTIGATION: The officer will have the ability to conduct an independent investigation on an electronic systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) AND SPACE SYSTEMS PROGRAMS

Curricular Officer:
Shelley P. Gallup
LCDR, USN
Code 39, Spanagel Hall
Room 203
(408) 656-2772
DSN 878-2772

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) CURRICULUM 365

The Joint C3 curriculum is designed to meet broad educational objectives endorsed by the Joint Chiefs of Staff. The overall objective is to provide officers and DoD civilian equivalents, through graduate education, with a comprehensive operational and technical understanding of the field of Command, Control and Communications systems as applied to joint and combined military operations at the national and unified command levels. The program is designed with the following goals: enable individuals to develop an understanding of the role C3 systems play in the use of military power and the ability to interpret the impact of C3 on operating philosophy; provide adequate background knowledge in basic technology, human capabilities and joint military operations and how these factors are exploited in current C3 systems; and, provide the framework whereby students can perform requirement and planning studies of new C3 systems and contribute to crisis management.

These officers should be able to undertake a wide range of assignments in C3 (both joint and intra-service) over the full span of their careers.

REQUIREMENTS FOR ENTRY

The Joint C3 curriculum is open to all U.S. Military Services and selected civilian employees of the U.S. Federal Government. Admission requires a baccalaureate degree with above-average grades and mathematics through differential and integral calculus. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable. An APC of 325 is required for direct entry. Officers not meeting the academic requirements for direct input may enter the program via one or two quarters of Engineering Science (Curriculum 460).

JOINT COMMAND, CONTROL AND COMMUNICATIONS (C3) SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Joint Command, Control and Communications (C3) Subspecialist with a subspecialty code of XX45P. The curriculum sponsor is the Directorate for Command, Control and Communications Systems (J6), Joint Staff.

Typical Jobs in this Subspecialty:
Staff Command and Control Officer: Commander in Chief, Pacific Fleet
Surface Systems Officer: Naval Ocean Systems Center
ADP Plans Officer: World Wide Military Command and Control System Joint Program Office
Staff Operations Plans Officer: Headquarters, European Command
Staff Operations and Plans Officer: Commander 7th Fleet
Programs Manager: Naval Space and Warfare Systems Command

ENTRY DATES

Joint Command, Control and Communications (C3) is a seven-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 365
Academic Associate:
Dan C. Boger, Professor
Code AS/Bo, Ingersoll Hall, Room 241
(408) 656-2607, DSN 878-2607.

DEGREE
Requirements for the degree Master of Science in Systems Technology [Joint Command, Control and Communications (C3)] are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

CC3000	(4-0)	Introduction to C3
CS2970	(4-1)	ADA Programming
MA1117	(5-2)	Single Variable Calculus
NS3252	(4-0)	Joint & Maritime Strategic Planning

Quarter 2

CC3001	(4-0)	Modelling C3 Systems
OS2103	(4-1)	Applied Probability
OS3404	(3-2)	Man-Machine Interaction
MA1248	(4-1)	Applied Mathematics

Quarter 3

CC4001	(4-2)	C3 System Architecture and Engineering I
EO2710	(4-2)	Introduction to Signals and Systems
OS3008	(4-0)	Analytical Planning Methodology
OS3604	(4-0)	Decision and Data Analysis

Quarter 4

CC4002	(4-2)	C3 System Architecture and Engineering II
EO2750	(4-2)	Communications Systems
MR2419	(2-0)	Meteorology for C3
CS3010	(4-0)	Computer Organization and Architecture

Quarter 5

CC4003	(2-4)	C3 Systems Evaluation
EO3750	(3-1)	Communications System Analysis
OS3603	(3-1)	Simulation and Wargaming
		Emphasis Elective

Quarter 6

CC4113	(4-0)	C3 Systems Issues
MN3301	(4-0)	System Acquisition and Project Management
CC0810	(0-0)	Thesis
		Emphasis Elective

Quarter 7

IS4320	(4-0)	Database System and Information Management
CC0810	(0-0)	Thesis
CC0810	(0-0)	Thesis
		Emphasis Elective

SPACE SYSTEMS OPERATIONS
CURRICULUM 366
The Space Systems Operations curriculum is designed to provide officers with an appreciation for military opportunities and applications in space, comprehensive, practical,

as well as theoretical knowledge of the operation, tasking and employment of space surveillance, communications, navigation and atmospheric/oceanographic/ environmental sensing systems and a knowledge of payload design and integration.

REQUIREMENTS FOR ENTRY
This curriculum is open to officers of the U.S. Armed Forces and selected civilian employees of the U.S Federal Government. Admission requires a baccalaureate degree with above-average grades, completion of mathematics through differential and integral calculus, plus at least one course in calculus-based physics. Students lacking this background may matriculate through the Engineering Science program (Curriculum 460). A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

SPACE SYSTEMS OPERATIONS SUBSPECIALTY
Completion of this curriculum qualifies an officer as a Space Systems Operations Subspecialist with a subspecialty code of XX76P. The curriculum sponsor is OP-943, Navy Space Systems Division.

Typical Jobs in this Subspecialty:
Commanding Officer: Naval Space Surveillance Systems
Plans Officer: North American Aerospace Defense Command
Advanced Concepts Officer: Naval Space and Warfare Systems Command
Space Defense Director: North American Aerospace Defense Command

ENTRY DATES
Space Systems Operations is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 366
Academic Associate:
Dan C. Boger, Professor
Code AS/Bo, Ingersoll Hall, Room 241
(408) 656-2607, DSN 878-2607

DEGREE
Requirements for the degree Master of Science in Systems Technology (Space Operations) are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1		
SS2001	(4-0)	Introduction to Space
MA1118	(5-2)	Multivariable Calculus
CS2970	(4-1)	Structured Programming with ADA
OS2103	(4-1)	Applied Probability for Systems Technology
Quarter 2		
PH1312	(4-2)	Electricity and Magnetism
MA1248	(4-1)	Selected Topics in Applied Mathematics for C3, Space Operations and Communications Management
IS3020	(3-2)	Software Design
OS3604	(4-0)	Decision and Data Analysis
Quarter 3		
PH2511	(4-0)	Introduction to Orbital Mechanics
CC3111	(4-0)	C3 Missions and Organization

EO2710	(4-2)	Introduction to Signals and Systems
OS3008	(4-0)	Analytical Planning Methodology

Quarter 4

SS3001	(4-0)	Military Applications of Space
PH2514	(4-0)	Introduction to the Space Environment
EO2750	(4-2)	Communications Systems
MN3301	(4-0)	Systems Acquisition

Quarter 5

SS4001	(4-0)	Decisions and Space Systems
EO3750	(3-1)	Communications Systems Analysis
OS3603	(3-1)	Simulation and Wargaming
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 6

AE4830	(3-2)	Spacecraft Systems I
SS3525	(4-2)	Remote Sensing
SS0810	(0-0)	Thesis Research
		Six Week Experience Tour

Quarter 7

AE4831	(4-0)	Spacecraft Systems II
SS0810	(0-0)	Thesis Research
XXXXXX		Track Option
XXXXXX		Track Option

Quarter 8

SS4002	(4-0)	Space Warfare Systems Evaluation
SS0810	(0-0)	Thesis Research
SS0810	(0-0)	Thesis Research
XXXXXX		Track Option

SPACE SYSTEMS ENGINEERING CURRICULUM 591

The Space Systems Engineering program provides officers, through graduate education, with a comprehensive scientific and technical knowledge of military and Navy space systems. This curriculum is designed to equip officers with the theoretical and practical skills required to design and integrate military space payloads with other spacecraft subsystems. Officer graduates will be prepared by their education to design, develop and manage the acquisition of space communications, navigation, surveillance, electronic warfare and environmental sensing systems.

REQUIREMENTS FOR ENTRY

A baccalaureate degree, or its equivalent, in engineering or the physical sciences is preferred. An APC of 323 is required for direct entry. The Engineering Science program (Curriculum 460) is available for candidates who do not meet all admission requirements. The additional time required will vary with the candidate's background. For those undertaking the electrical engineering program, the officer will have earned the equivalent of an accredited BSEE. A TOP SECRET security clearance is required with SPECIAL INTELLIGENCE (SI) clearance obtainable.

SPACE SYSTEMS ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Space Systems Engineering Specialist with a subspecialty code of XX77P. The curriculum sponsor is OP-943, Navy Space Systems Division.

Typical Jobs in this Subspecialty:

Assistant Project Manager Satellite Communications: SPAWAR
Manager: Navy Space Project SPAWAR

Head DMSP and NAVDEP: Joint Program Office Navy Space Systems Activity, Los Angeles, CA
Assistant for Navigation Systems: CNO OP-943DI
MILSTAR Systems Engineering: Navy Space Systems Activity, Los Angeles, CA
Head Satellite Surveillance: CNO OP-986E
Launch and Control Systems Officer: Naval Space Command
Assistant for TENCAP Systems: OP-943E11
Plans and Project Officer: Naval Space Surveillance Systems
Electronics Engineering Systems
Department Head: Navy Astronautics Group, Pt. Mugu, CA

ENTRY DATES

Space Systems Engineering is a nine-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer.

Curriculum 591
Academic Associate:
Conrad Newberry, Professor
Code AA/Ne, Halligan Hall, Room 233
(408) 656-2892, DSN 878-2892

DEGREE

Requirements for one of eight technical degrees are met as a milestone en route to satisfying the Educational Skill Requirements of this curricular program. The possible degrees are: Master of Science in Engineering Science, Computer Science, Electrical Engineering, Mechanical Engineering, Physics, Aeronautical Engineering, Astronautical Engineering or Mathematics.

TYPICAL COURSE OF STUDY

Quarter 1

MA2121	(4-0)	Differential Equations
PH1322	(4-1)	Electricity and Magnetism
EC2820	(3-2)	Digital Logic Circuits
CS2970	(4-1)	Structured Programming with ADA

Quarter 2

PH2514	(4-0)	Introduction to Space Environment
PH2511	(4-0)	Orbital Mechanics
EC2400	(3-0)	Discrete Systems
EC2410	(3-0)	Fourier Analysis

Quarter 3

XXXXXX	(4-0)	Track Option
EC2420	(3-0)	Linear Systems
XXXXXX	(4-0)	Track Option
PH3360	(4-1)	EM Waves and Propagation

Quarter 4

EC2300	(3-2)	Control Systems
EC2500	(3-2)	Communications Theory
XXXXXX	(4-0)	Track Option
SS3001	(4-0)	Space Warfare Systems Operations

Quarter 5

AE3851	(3-2)	Spacecraft Propulsion
AE3815	(4-0)	Spacecraft Dynamics

XXXXXX	(4-0)	Track Option
AE2820	(3-2)	Spacecraft Structures

Quarter 6

EO3740	(3-0)	Space Power
AE3804	(2-0)	Thermal Control
SS3525	(3-2)	Remote Sensing
		Six Week Experience Tour

Quarter 7

SS3035	(3-2)	Microprocessors
AE4818	(3-1)	S/C Attitude Dynamics and Control
XXXXXX	(4-0)	Track Option
SS0810	(0-0)	Thesis

Quarter 8

NS3252	(4-0)	Joint and Maritime Strategic Planning
AE4870	(4-0)	Spacecraft Design I
XXXXXX	(4-0)	Track Option
SS0810	(0-0)	Thesis

Quarter 9

MN3301	(4-0)	Systems Acquisition
AE4871	(4-0)	Spacecraft Design II
SS0810	(0-0)	Thesis
SS0810	(0-0)	Thesis

EDUCATIONAL SKILL REQUIREMENTS COMMAND, CONTROL & COMMUNICATION CURRICULUM (365)

The Joint C3 Curriculum is designed to meet broad educational objectives endorsed by the Joint Staff and the Services. The overall objective is to provide a comprehensive technical understanding in the field of Command, Control and Communications Systems. The general objectives are to develop individuals who can:

1) Analyze technical requirements and perform planning studies of C3 systems.

2) Understand the technical requirement for interoperability between C3 systems and programs designed to ensure interoperability.

3) Understand the role of C3 systems in military operations.

4) Understand human-C3 systems interactions and related technologies.

The graduate should be able to analyze the technical and operational aspects of C3 environments and effectively interface with engineers, planners and operational personnel in the development of new C3 systems and the improvement of existing C3 systems through the use of the following skills.

ANALYSIS OF C3 SYSTEMS:

1) To analyze technical requirements and perform planning studies of C3 systems, the graduate will:

   a) Understand and apply basic C3 systems technology, including basic physical principles, capabilities and limitations of telecommunications and sensors (to include radars, analog and digital systems with emphasis on digital systems). Understand the atmospheric/meteorological effects on telecommunication and sensor systems.

   b) Understand the capabilities and limitations of computers including networking, operating systems, software and hardware, and programming concepts.

   c) Understand database management systems with emphasis on C3 applications.

   d) Understand Defense acquisition, including the PPBS, evolutionary acquisition, PPPI program, NDI, COTS and the CINC PPBS input with emphasis on command and control systems.

2) To understand the technical requirement for interoperability between C3 systems and the programs designed to ensure interoperability, the graduate will:

   a) Understand technical interoperability parameters of command and control systems (including the path, the information traveling on the path and the processing of the information).

b) Analyze and evaluate C3 systems for effectiveness and efficiency through modelling and simulations. Design, implement and use simulation models with emphasis on C3 and interpret the results. Understand the relationships of intelligence, air operations, fire support and maneuver, maritime, administration and logistics and management information systems to the C3 function.

c) Be familiar with programs and organizations (agencies, boards and panels) associated with interoperability including the OSD/C3I, MCEB, IIP, JTC3A Center for Standards, T2C3 Panel and the Five Year Interoperability Assurance Plan (FYIAP); and, use the architectures developed by DCA, JTC3A (FIA's), DIA (TIAP, INCA), etc., as current examples.

3) To understand the role of C3 systems in military operations, the graduate will:

a) Understand the role of C3 systems in the use of military power. Understand C3 systems. Understand the C3 management structure of DoD. Understand the structure of DoD and Joint and Unified Commands.

b) Understand the threat to C3 systems. Understand the availability of intelligence products. Understand the intelligence tasking process.

c) Understand and identify requirements for C3 systems. Interface with engineers and operational personnel in the development of new, and the improvement of existing C3 systems. Interpret the impact of C3 systems on operational philosophies. Synthesize the command and control needs of the operators/users during crisis management.

d) Synthesize the educational and operational experience to determine requirements using systems engineering concepts.

4) To understand human-C3 systems interactions and related technologies, the graduate will:

a) Understand the human's capabilities and limitations and how these can affect the optimum design of C3 systems. Understand the impacts of different environments (air/land/sea). Understand the relationships between information processing and collection and information overload (focus on memory). Understand the applications of technology (e.g., DDN, voice recognition, security devices, data display - graphics, video, etc). Understand the relationships of accuracy, timeliness, precision, and other factors to the value of information.

b) Understand the application of decision support systems and artificial intelligence to the decision making process.

c) Understand and apply the concepts of operational analysis as it pertains to the decision making process. Includes areas of probability, model formulation (linear and non-linear programming, networks, flow and scheduling, decision analysis, etc) and statistics and data analysis.

EDUCATIONAL SKILL REQUIREMENTS
SPACE SYSTEMS OPERATIONS
CURRICULUM (366)

The objective of this curriculum is to provide graduate-level education such that the graduating officers will have: an understanding of force enhancement, space support, space control, and force application of space systems; a comprehensive practical and theoretical knowledge of the operation, tasking, and employment of space surveillance, communications, navigation, and sensing systems; and, knowledge of payload design and integration. Officer graduates will be prepared to develop the requirements, strategy, and doctrine for acquiring, planning, managing, analyzing, and exploiting current and future space systems.

To implement these objectives the following Educational Skill Requirements areas are included in the Space Systems Operations Curriculum:

JOINT AND MARITIME STRATEGIC PLANNING: A graduate level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning, and current issues in defense reorganization.

MILITARY OPERATIONS INVOLVING SPACE: The ability to derive, assess and articulate; cost-effective requirements for the design, performance, and operational use of space systems; strategies, plans, doctrine, tactics, and operational concepts for the employment of space systems; the nature of space warfare, including the options available to protect U.S. and Allied assets and to deny the hostile use of space to others; the roles, responsibilities, and relationships of national, DoD, and Navy organizations involved in the design, acquisition, and operation of space systems; the policies of these organizations governing the management of military operations in space; intelligence collection and analysis processes and information systems and their interactions with command and control systems.

COST EFFECTIVENESS AND ANALYTIC MODELING TECHNIQUES: An understanding of, and the ability to perform, cost-effective trade-offs, involving alternative system concepts or system architectures, among elements of spacecraft design and system operations and tasking, including the space and terrestrial segments.

The ability, through simulation, modeling and other analytic techniques, to evaluate the contribution of space systems to warfare and to determine and define the role of space systems in strategic and tactical command and control architectures at both Navy and national levels.

ORBITAL MECHANICS, SPACE ENVIRONMENT AND REMOTE SENSING: An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Perturbations due to nonspherical earth and due to atmospheric drag. Relationships of orbits to mission requirements.

An appreciation of the natural and induced environment of space including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances.

An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage., resolution, processing and power requirements.

PROJECT MANAGEMENT: An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships; financial management and control; and the planning, programming and budgeting system (PPBS).

COMPUTER SYSTEMS: General knowledge of the design and operation of computer systems, to include basic computer organization and architecture, software engineering and database management methodologies, and a rudimentary skill in at least one widely used high-level programming language, including ADA.

COMMUNICATIONS SYSTEMS: A systems level understanding of digital and analog communications systems and their integration into a complete, networked communication system in multiple environments to include C3CM and electronic warfare.

SPACECRAFT DESIGN AND SYSTEMS INTEGRATIONS: A basic understanding of the major factors in and constraints on spacecraft design, including guidance and control dynamics and structures, propulsion and power, and thermal control and their interactions with the remainder of the space and terrestrial segments.

CONDUCT AND REPORT INDEPENDENT RESEARCH: The ability to conduct independent research on a space systems problem, to resolve the problem and to present the results of the analysis in both written and oral form.

EDUCATIONAL SKILL REQUIREMENTS
SPACE SYSTEMS ENGINEERING
CURRICULUM (591)

The objective of this curriculum is to provide graduate level education such that the graduating officers will be technically qualified to manage programs involving conceptualization, design, development, acquisition testing and operation of military space systems and necessary ground support activities.

To implement these objectives the following Educational Skill Requirements areas should be included in the Space Systems Engineering Curriculum:

JOINT MARITIME STRATEGIC PLANNING: A graduate level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

ORBITAL MECHANICS AND SPACE ENVIRONMENT: An understanding of the basic physics of orbital motion, the parameters used in the description of orbits and their ground tracks and how orbits are achieved. Perturbations due to nonspherical earth and due to atmospheric drag.

An appreciation of the natural and induced environment of space including solar activity, geomagnetic and magnetospheric phenomena, physics of the ionosphere and upper atmosphere and their response to natural and artificial disturbances.

An understanding of the principles of active and passive sensors used in spacecraft for sensing through the atmosphere. Knowledge of the effects of the space environment and countermeasures on sensor performance. An understanding of tradeoffs among various sensor techniques, including area of coverage, resolution, processing, and power requirements.

COMMUNICATIONS AND SIGNAL PROCESSING: An appreciation of fundamental signal processing techniques, both digital and analog, in connection with communications, surveillance, and EW.

COMPUTERS (Hardware and Software): A programming skill in at least one high level computer programming language, such as ADA, PASCAL or FORTRAN.

An understanding of the fundamentals of digital logic and digital system design. An ability to design simple digital computer subsystems.

Knowledge of a typical computer architecture, such as one of the common 16-bit or 32-bit micro-processor systems. Understanding of the ways in which computers are used in complex systems such as guidance, signal processing, communications and control systems.

SPACECRAFT GUIDANCE AND CONTROL: An understanding of the field of attitude dynamics and control which includes: Classical Newtonian dynamics, 3 axis attitude stabilization, dual spin stabilization, nutation damping control; momentum wheels, gravity gradient booms, attitude beam pointing accuracy and

thrust vector books and thrust vector control. Knowledge of minimum fuel and time type control systems.

SPACECRAFT STRUCTURE, MATERIALS & DYNAMICS: An understanding of the engineering of space structures including modeling of advanced system design and simplified sizing calculation and analytical materials which can be incorporated in integration.

An ability to apply reliability and maintainability to testing, evaluation, and manufacturing which can be used to predict the functional dependability of spacecraft structures.

PROPULSION SYSTEMS: An understanding of the operating principles of current and proposed propulsion devices for space applications; including launch, orbit changing and maneuvering engines.

An understanding of the interaction between mission requirements and propulsion requirements.

SPACECRAFT THERMAL CONTROL & POWER: An understanding of the principles of heat transfer by radiation and of the variations in the radiative properties of surfaces with respect to wavelength and temperature.

A knowledge of the sources of heat in space (solar, terrestrial, reflected solar, internal vehicle generation) and their variation as a function of vehicle orbit.

A knowledge of the major power generating systems for spacecraft and their operating characteristics, including the performance of photovoltaic sources in the natural and artificial radiation environment. An understanding of the role of energy storage devices in power systems design.

SPACECRAFT DESIGN & INTEGRATION: An understanding of the principles of spacecraft design and integration, including formulation of design criteria from stated performance requirements, trade-offs between payload and other spacecraft subsystems and a familiarity with test and evaluation procedures.

MILITARY OPERATIONS IN SPACE: An appreciation of space weapons, defense and warfare including options available to protect space assets and to deny the use of space to others. A familiarity with the role, responsibilities and relationships of national, DoD and Navy organizations involved in the design, acquisition and operation of space systems and with national policies governing military operations in space.

PROJECT MANAGEMENT: An understanding of project management and defense system acquisition methods and procedures to include organizational responsibilities and relationships, financial management and control and the planning, programming and budgeting (PPBS) system.

CONDUCT AND REPORT INDEPENDENT RESEARCH: The ability to conduct independent research on a space systems problem, to resolve the problem, and to present the results of the analysis in both written and oral form.

NATIONAL SECURITY AND INTELLIGENCE PROGRAMS

Curricular Officer:
Terry W. Tiernay, CDR, USN
Code 38, Root Hall, Room 216
(408) 656-2228, DSN 878-2228

Assistant Curricular Officer
Steven S. Thayer, LCDR, USN
Code 381, Root Hall, Room 211
(408) 656-2845, DSN 878-2845

AREA STUDIES
CURRICULA 681-684

Area studies curricula focus on the history, culture and religion of a specific region or country. Each curriculum provides students with a knowledge of current issues, economic and political structures and institutions, military forces, including strategic capabilities and policy implications and geopolitical influences of the studied region.

REQUIREMENTS FOR ENTRY

Prospective students must be military officers or civilian employees of the U.S. Federal Government or allied nations. Students must have a baccalaureate degree earned with above-average academic performance and an APC of 355. Foreign military officers must have an ECL proficiency rating of 80 or better to be considered for admission. College level preparation in basic descriptive and inferential statistics is required.

ENTRY DATES

Area studies are six-quarter courses of study with entry dates in January and July. For U.S. Army and Air Force Officers there is a modified academic program which combines studies at the Defense Language Institute and the Naval Postgraduate School. If further information is needed, contact the Academic Associate or the Curricular Officer for these curricula.

Curricula 681-684
Academic Associate:
M. Tsypkin, Associate Professor
Code NS/Tk, Root Hall, Room 103J
(408)656-2218/2521, DSN 878-2218/2521

DEGREE

Requirements for the degree of Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricula programs.

MID EAST, AFRICA, SOUTH ASIA SUBSPECIALTY

Completion of the 681 curriculum qualifies an officer as a Mid East, Africa, South Asia Subspecialist with a subspecialty code of XX21. The curriculum sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Operations Intelligence: Commander Middle East Force
POL-MIL Planner: Joint Chiefs of Staff, Washington, DC
Mid East/Southwest Asia Policy: CINCUSNAVEUR LONDON
Area Officer: DIA
Head, Middle East, Asia, Southwest Asia: OP-611
Military Assistance Program: Military Liaison Office Tunisia

FAR EAST, SOUTHEAST ASIA, PACIFIC SUBSPECIALTY

Completion of the 682 curriculum qualifies an officer as a Far East, Southeast Asia, Pacific Subspecialist with a subspecialty code of XX22. The curriculum sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Chief of Staff: COMNAVBASE GUAM
Staff Operations and Plans: CINCPACFLT
Faculty Member: DIC
OP-635C Assistant for Military Sales: OPNAV-FOREIGN MILITARY
Analyst: OPNAVSUPPACT, Washington, DC

WESTERN HEMISPHERE SUBSPECIALTY
Completion of the 683 curriculum qualifies an officer as a Western Hemisphere Subspecialist with a subspecialty code of XX23. The curriculum sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Political Military Planner: Joint Chiefs of Staff
Executive Assistant: Inter American Defense
Strategy and Policy Central and South Atlantic: USCINCLANT
Intelligence Analyst: USCINSCO
Area Officer: DIA
Assistant for Military Sale: OPNAV-FOREIGN MILITARY
OP-613 Assistant Branch Head: South America

RUSSIA, EUROPE, CENTRAL ASIA
Completion of the 684 curriculum qualifies an officer as a Russia, Europe, Central Asia Subspecialist with a subspecialty code of XX24. The curriculum sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Staff Plan: NATO
ACOS for Plans: SACLANT
POL-MIL Planner: Joint Chiefs of Staff
Geopolitical Intelligence Office: CINCUSNAVEUR LONDON
Atlantic Allied Plans: COMINEWARCOM

TYPICAL COURSE OF STUDY

MIDDLE EAST, AFRICA, SOUTH ASIA - CURRICULUM 681

Quarter 1

NS3011	(4-2)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3300	(4-0)	History and Cultures of the Middle East
NS3310	(4-0)	Government and Politics in the Middle East

Quarter 2

NS3040	(4-0)	The Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3024	(4-0)	Introduction to International Relations
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 3

NS3320	(4-0)	U.S Interests and Policies in the Middle East
NS3041	(4-0)	Comparative Economic Systems
NS4300	(4-0)	Seminar in Middle Eastern Politics
NS3XXX	(4-0)	Elective

Quarter 4

NS3360	(4-0)	Topics in Middle Eastern Politics
NS4310	(4-0)	Seminar in Middle Eastern Security Issues
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS0810	(0-0)	Thesis Research

Quarter 5

NS3361	(4-0)	Topics in Middle Eastern Security
NS4XXX	(4-0)	Elective
NS3038	(4-0)	International Naval Power and Policy
NS0810	(0-0)	Thesis Research

Quarter 6

NS4XXX	(4-0)	Elective
NS3902	(4-0)	Modern Revolution
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

TYPICAL COURSE OF STUDY

FAR EAST, SOUTHEAST ASIA, PACIFIC - CURRICULUM 682

Quarter 1

NS3011	(4-0)	Policy Analysis and Research Methods for Area Studies
NS3023	(4-0)	Introduction to Comparative Politics
NS3600	(4-0)	Geography and History of Asia
NS3601	(4-0)	Values and Belief Systems of Asia

Quarter 2

NS3040	(4-0)	Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3620	(4-0)	Asia and the Modern World
NS3024	(4-0)	Introduction to International Relations

Quarter 3

NS3663	(4-0)	Government Security in Korea
NS3041	(4-0)	Comparative Economic Systems
NS3252	(4-0)	Joint and Maritime Strategic Planning
NS4XXX	(4-0)	Elective

Quarter 4

NS3667	(4-0)	Government and Security in South Asia, Southeast Asia, and Oceanic Regions
NS3037	(4-0)	The role of congress in U.S. National Security Policy
NS4XXX	(4-0)	Elective
NS0810	(4-0)	Thesis Research

Quarter 5

NS3661	(4-0)	Government and Security in China
NS3038	(4-0)	International Naval Power and Policy
NS4660	(4-0)	Seminar in Asia in World Affairs
NS0810	(4-0)	Thesis Research

Quarter 6

NS3662	(4-0)	Government and Security in Japan
NS4690	(4-0)	Seminar in International Security Issues of Asia
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

TYPICAL COURSE OF STUDY

WESTERN HEMISPHERE - CURRICULUM 683

Quarter 1

NS3011	(4-2)	Policy Analysis & Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3501	(4-0)	History and Culture of Latin America
NS3510	(4-0)	Government and Politics in Latin America

Quarter 2

NS3040	(4-0)	Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy/Defense Organization
NS3024	(4-0)	Introduction to International Relations
NS3252	(4-0)	Joint & Maritime Strategic Planning

Quarter 3

NS3041	(4-0)	Comparative Economic Systems
NS3520	(4-0)	Latin America International Relations
NS3XXX	(4-0)	Elective
NS4510	(4-0)	Latin American Government and Politics

Quarter 4

NS3XXX	(4-0)	Elective
NS4560	(4-0)	Seminar in Latin American Security Issues
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS0810	(0-0)	Thesis Research

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS4XXX	(4-0)	Elective
NS3XXX	(4-0)	SOLIC Course TBD
NS0810	(0-0)	Thesis Research

Quarter 6

NS3902	(4-0)	Modern Revolution
NS4XXX	(4-0)	Elective
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

TYPICAL COURSE OF STUDY

RUSSIA, EUROPE, AND CENTRAL ASIA - CURRICULUM 684

TRACK 1 - WESTERN EUROPE

Quarter 1

NS3011	(4-0)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3700	(4-0)	History of Modern Europe
NS3710	(4-0)	Government and Security in Western Europe

Quarter 2

NS3040	(4-0)	Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3720	(4-0)	European Security Institutions
NS3024	(4-0)	Introduction to International Relations

Quarter 3

NS3041	(4-0)	Comparative Economic Systems
NS3460	(4-0)	Government & Security in Eastern Europe
NS4710	(4-0)	Seminar in Political and Security Problems of Europe
NS3252	(4-0)	Joint & Maritime Strategic Planning

Quarter 4

NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe, and Central Asia
NS4720	(4-0)	Seminar in European Issues
NS0810	(0-0)	Thesis Research

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS3XXX	(4-0)	Elective
NS4XXX	(4-0)	Elective
NS0810	(0-0)	Thesis Research

Quarter 6

NS3905	(4-0)	Modern Revolution
NS4XXX	(4-0)	Elective
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

TYPICAL COURSE OF STUDY

TRACK 2 - RUSSIA, EASTERN EUROPE, CENTRAL ASIA

Quarter 1

NS3011	(4-0)	Policy Analysis and Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3400	(4-0)	Government and politics in Russia, Eastern Europe and Central Asia
NS3401	(4-0)	The Peoples of Russia, Eastern Europe and Central Asia

Quarter 2

NS3040	(4-0)	Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3410	(4-0)	Russia, Eastern Europe and Central Asia in World Affairs
NS3024	(4-0)	Introduction to International Relations

Quarter 3

NS3041	(4-0)	Comparative Economic Systems
NS3460	(4-0)	Problems of Government and Security in Eastern Europe
NS3252	(4-0)	Joint & Maritime Strategic Planning
NS4410	(4-0)	Soviet Security Problems

Quarter 4

NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
NS4720	(4-0)	Seminar in European Security Issues
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS0810	(0-0)	Thesis Research

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
NS3XXX	(4-0)	Elective
NS4XXX	(4-0)	Elective
NS0810	(0-0)	Thesis Research

Quarter 6

NS3720	(4-0)	European Security Institutions
NS4XXX	(4-0)	Elective
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

STRATEGIC PLANNING
CURRICULUM 688

This curriculum is designed to provide students with a wide knowledge and thorough understanding of the complex, interrelated variables in both the domestic and international environments when evaluation strategic planning options and supportive negotiating positions in the formulation of U.S. national security policy.

REQUIREMENTS FOR ENTRY

Open to officers and civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation within the past five years. A baccalaureate degree earned with above-average academic performance and a minimum APC of 345 are required.

ENTRY DATES

Strategic Planning is an eight-quarter course of study with entry dates in January and July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 688
Academic Associate:
Frank M. Teti, Associate Professor
Code NS/Tt, Root Hall, Room 201
(408) 656-2528/2521, DSN 878-2528/2521

STRATEGIC PLANNING AND INTERNATIONAL ORGANIZATIONS AND NEGOTIATIONS SUBSPECIALTY

Completion of the 688 curriculum qualifies an officer as a Strategic Planning Specialist with a subspecialty code of XX28. The curriculum sponsor is OP-06, Chief of Naval Operations (Plans, Policy and Operations).

Typical Jobs in this Subspecialty:
Representative for International Negotiations: JCS
Military Assistant: U.S. Arms Control and Disarmament
Assistant for Nuclear Negotiations: OPNAV
Head Trident Strategic Weapons: OPNAV
SSBN Current Operations: USCINCLANT
War Plans: CINCUSNAVEUR

DEGREE

Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

NS3011	(4-2)	Policy Analysis & Research Methods
NS3000	(4-0)	War in the Modern World
NS3023	(4-0)	Introduction to Comparative Politics
NS3154	(4-0)	Intelligence and the Military

Quarter 2

NS3040	(4-0)	The Politics of Global Economic Relations
NS3030	(4-0)	American National Security Policy
NS3252	(4-0)	Joint & Maritime Strategic Planning
NS3024	(4-0)	Introduction to International Relations

Quarter 3

NS3012	(4-0)	Forecasting and Gaming Methods for Strategic Planners
NS3230	(4-0)	Strategic Planning and the Military
NS3280	(4-0)	Nuclear Strategy and National Security
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia

Quarter 4

NS3250	(4-0)	The Economics of U.S. Defense Policy
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy

NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
NS3900	(4-0)	International Law and Organizations

Quarter 5

NS3038	(4-0)	International Naval Power and Policy
MN3XXX	(4-0)	Administrative Sciences Elective
NS4280	(4-0)	Seminar in Nuclear Strategy
NS3XXX	(4-0)	Elective

Quarter 6

OS3XXX	(4-0)	Operations Research Elective
NS4250	(4-0)	Seminar in Security Assistance and Arms Transfer
NS3XXX	(4-0)	Elective
NS0810	(0-0)	Thesis Research

Quarter 7

NS4900	(4-0)	Seminar in International Negotiations
NS3XXX	(4-0)	Elective (Non-Russian Area Studies)
NS4XXX	(4-0)	Elective
NS0810	(0-0)	Thesis Research

Quarter 8

NS4230	(4-0)	Seminar in Strategic Planning
NS4XXX	(4-0)	Elective
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

SPECIAL OPERATIONS/LOW INTENSITY CURRICULUM 699

This new curriculum is designed to provide students with specialized knowledge of the broad range of factors involved in the phenomenon of low intensity conflict, to include an appreciation of the multiple facets of the causes and consequences of different forms of political violence, ranging from terrrorism to mid-level conflict.

REQUIREMENTS FOR ENTRY

Curriculum is open to officers and civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the past five years. A baccalaureate degree earned with above-average academic performance and minimum APC of 355.

ENTRY DATES

Special Operations/Low Intensity Conflict is a six-quarter course of study with an entry date in July. If further information is needed, contact the Academic Associate of the Curricular Officer for this curriculum.

CURRICULUM 699

Academic Associate:
Gordon H. McCormick, Associate Professor
Code NS/Mc, Root Hall, Room 201H
(408) 656-2521, DSN 878-2521

SPECIAL OPERATIONS/LOW INTENSITY CONFLICT SUBSPECIALTY

Completion of the 699 curriculum qualifies an officer as a Special Operations/Low Intensity Conflict Subspecialist with a subspecialty code of XX29. The curriculum sponsor is Commander Naval Special Warfare Command.

Typical Jobs in this Subspecialty:
Chief, Political Strategy: USCINCSOC
Asst Missions/Readiness: ASD (SO/LIC)
Special Warfare Plans: CINCLANT/CINCPAC/NACEUR
Chief Intel/Plans: COMNAVSPECWARCOM
Joint Plans/Doctrine: COMNAVSPECWARCOM
Staff Plans: CNSWG-1

TYPICAL COURSE OF STUDY

Quarter 1

NS3011	(4-2)	Policy Analysis & Research Methods
NS3023	(4-0)	Introduction to Comparative Politics
NS3000	(4-0)	War in the Modern World
NS3252	(4-0)	Joint & Maritime Strategic Planning

Quarter 2

NS3030	(4-0)	American National Security Policy
NS3024	(4-0)	Introduction to International Relations
NS3800	(4-0)	Theory and Practice of Social Revolution
NS3801	(4-0)	International Terrorism

Quarter 3

NS3XXX	(4-0)	Elective
NS4XXX	(4-0)	Area Studies Elective
NS3880	(4-0)	History of Special Operations
NS3881	(4-0)	Intervention and Mid-Level Conflict

Quarter 4

NS4860	(4-0)	Regional Seminar in Low Intensity Conflict: Asia
NS4850	(4-0)	Regional Seminar in Low Intensity Conflict: Latin America
NS3037	(4-0)	The Role of Congress in U.S. National Security Policy
NS0810	(0-0)	Thesis Research

Quarter 5

NS3036	(4-0)	The Military and Politics in the Developing World
NS4830	(4-0)	Regional Seminar in Low Intensity Conflict: Middle East
NS3154	(4-0)	Intelligence and the Military
NS0810	(0-0)	Thesis Research

Quarter 6

MN3154	(4-0)	Financial Management in the Armed Forces
NS3040	(4-0)	The Politics of Global Economic Relations
NS4080	(4-0)	Research Colloquium
NS0810	(0-0)	Thesis Research

INTELLIGENCE
CURRICULUM 825

This curriculum consists of three emphasis tracks: Track 1 - Scientific and Technical Intelligence, Track 2 - Soviet Studies-Intelligence and Track 3 - Operational Intelligence (OPINTEL). Students in the intelligence curricula will gain a thorough understanding of the U.S. Intelligence Community and its current and future operations; a general understanding of the scientific and technical factors which bear on intelligence; and a general understanding of world regional powers and the role of their military, particularly naval forces. The foregoing will be used as a basis for students as they pursue coursework in one of the three emphasis tracks of intelligence. Two other broad study areas round out each curriculum: analysis and management, and national security affairs. The analysis and management sequence provides a good foundation in quantitative techniques and research methods. National Security Affairs courses address the interface between international politics and national security objectives.

REQUIREMENTS FOR ENTRY

Prospective students must be U.S. military officers or civilian employees of the U.S. Federal Government eligible for a TOP SECRET clearance with access to Sensitive Compartmented Information based on a Special Background Investigation completed within the past five years. They must have a baccalaureate degree earned with above-average academic performance and a minimum APC of 334 (Track 1), 355 (Track 2), or 255 (Track 3). In addition, Track 2 is limited to 163X designated officers only. A similar course of study (with less emphasis on intelligence and no language training) is available for other designators within the National Security Affairs Area Studies curricula.

ENTRY DATES

Scientific and Technical Intelligence (Track 1) is a six quarter program with a starting date in April. In addition, all students will report for a math and physics refresher in mid-February. Regional Studies Intelligence (Track 2) is an eight quarter program with a starting date in January or July. Operational Intelligence (Track 3) is either a four quarter (163X and USMC Intelligence Officer) or five quarter (other designators) course of study with a start date in July. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

INTELLIGENCE SUBSPECIALTY

Completion of any of the three curricula qualifies an officer as an Intelligence Subspecialist with one of the following subspecialty codes:

Track 1 - Scientific and Technical	XX17
Track 2 - Soviet Studies	XX18
Track 3 - OPINTEL	XX19

Typical Jobs in this Subspecialty:
Operations Intelligence Analyst: NAVOPINTCEN, Washington, DC
Technical Intelligence: COMNAVFOR JAPAN
Naval Attache: Attache USSR
Commander Shore Activity: NTIC, Washington, DC
Staff Operations/Submarine Operations: CINCUSNAVEUR LONDON
Intelligence Officer: COMSUBGRU
Surface Analyst: FOSIF ROTA/KAMISEYA
Tactical Intelligence: Office of the Secretary of Defense
Intelligence Officer: War College, Newport, RI
Intelligence Production Analyst: NORAD/ADCOM JNT SUPP

DEGREE

Requirements for the degree Master of Science in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the Scientific and Technical Intelligence (Track 1) program. Requirements for the degree Master of Arts in National Security Affairs are met en route to satisfying the Educational Skill Requirements of the Regional Studies Intelligence or OPINTEL programs.

Curriculum 825
Academic Associate:
T. Grassey, Associate Professor
Code NS/Gt, Root Hall, Room 201F
(408) 656-3450/2521, DSN 878-3450/2521

TYPICAL COURSE OF STUDY

TRACK 1 - Scientific and Technical Intelligence Refresher

MA0117	(0-0)	Refresher: Single Variable Calcuus
PH0110	(0-0)	Refresher: Physics

Quarter 1

PH1322	(4-0)	Basic Physics: Electricity and Magnetism
OC2001	(4-0)	Ocean Systems
EO2790	(4-0)	Survey of Communications Systems
CC3111	(4-0)	C3 Mission

Quarter 2

NS3154	(4-0)	Intelligence and the Military
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia
SE3301	(4-0)	Radiating Systems
NS3011	(4-2)	Policy Analysis & Research Methods

Quarter 3

IS3183	(4-0)	Management Information Systems
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
OS3002	(4-0)	Operations Research for Naval Intelligence
NS3151	(4-0)	Intelligence Systems and Products

Quarter 4

NS4152	(4-0)	Seminar in Intelligence and Threat Analysis
SS3001	(4-0)	Military Applications of Space
SE4006	(4-0)	Technical Assessment of Weapon Systems
NS0810	(0-0)	Thesis Research

Quarter 5

NS3030	(4-0)	American National Security Policy
NS4451	(4-0)	Seminar in Russian/Central Asian Naval Affairs
NS4230	(4-0)	Seminar in Strategic Planning
NS0810	(0-0)	Thesis Research

Quarter 6

NS3028	(4-0)	International Naval Power and Policy
NS3252	(4-0)	Joint & Maritime Strategic Planning
NS0855	(0-0)	Experience Tour
NS0810	(0-0)	Thesis Research

TRACK 2 - REGIONAL STUDIES INTELLIGENCE
FIRST YEAR
APPROPRIATE REGIONAL LANGUAGE STUDIES AT DEFENSE LANGUAGE INSTITUTE

Quarter 1

NS3011	(4-2)	Policy Analysis & Research Methods
NS3150	(4-0)	Science and Technology of Intelligence
NS3XXX	(4-0)	Regional Study Emphasis Area Course*
NS3XXX	(4-0)	Regional Study Emphasis Area Course*

Quarter 2

NS3151	(4-0)	Intelligence Systems and Products
NS3XXX	(4-0)	Regional Study Emphasis Area Course*
NS3252	(4-0)	Joint & Maritime Strategic Planning
IS3183	(4-0)	Management Information Systems

Quarter 3

NS4152	(4-0)	Seminar in Intelligence and Threat Analysis
NS3XXX	(4-0)	Regional Study Emphasis Area Course*
NS4XXX	(4-0)	Regional Study Emphasis Area Course*
NS0810	(0-0)	Thesis Research

Quarter 4

NS3030	(4-0)	American National Security Policy
NS4XXX	(4-0)	Regional Study Emphasis Area Course*
NS4999	(4-0)	Approved Elective
NS0810	(0-0)	Thesis Research

* Regional study emphasis area courses selected from the following corresponding NSA department area study programs: Curriculum 681, 682, 683, 684

TRACK 3 - OPINTEL

Quarter 1

NS3011	(4-2)	Policy Analysis and Research Methods
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia
NS3038	(4-0)	International Naval Power and Policy
NS3150	(4-0)	Science and Technology of Intelligence

Quarter 2

IS3183	(4-0)	Management Information Systems
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
OS3002	(4-0)	Operations Research for Naval Intelligence
NS3151	(4-0)	Intelligence Systems and Products

Quarter 3

NS4152	(4-0)	Seminar in Intelligence and Threat Analysis
NS3252	(4-0)	Joint and Maritime Strategic Planning
NS3159	(4-0)	Principles of Operational Intelligence
NS0810	(0-0)	Thesis Research

Quarter 4

NS3030	(4-0)	American National Security Policy
NS4451	(4-0)	Seminar in Russian/Central Eurasian Naval Affairs
NS4159	(4-0)	Seminar in Advanced Topics in Operational Intelligence
NS0810	(0-0)	Thesis Research

TRACK 3 (OPINTEL) WITH EXPERIENCE TOUR

Quarter 1

NS3011	(4-2)	Policy Analysis and Research Methods
NS3400	(4-0)	Government and Politics in Russia, Eastern Europe and Central Asia
NS3150	(4-0)	Science and Technology of Intelligence
NS3154	(4-0)	Intelligence and the Military

Quarter 2

IS3183	(4-0)	Management Information Systems
NS3450	(4-0)	Military Strategy in Russia, Eastern Europe and Central Asia
OS3002	(4-0)	Operations Research for Naval Intelligence
NS3151	(4-0)	Intelligence Systems and Products

Quarter 3

NS4152	(4-0)	Seminar in Intelligence and Threat Analysis
NS3159	(4-0)	Principles of Operational Intelligence
NS3XXX	(4-0)	Approved Elective
NS0810	(0-0)	Thesis Research

Quarter 4

NS3030	(4-0)	American National Security Policy
NS4451	(4-0)	Seminar in Russian/Central Eurasian Naval Affairs

NS4159	(4-0)	Seminar in Advanced Topics in Operational Intelligence
NS0810	(0-0)	Thesis Research

Quarter 5

NS3252	(4-0)	Joint and Maritime Strategic Planning
NS3038	(4-0)	International Naval Power and Policy
NS0855	(0-0)	Experience Tour
NS0810	(0-0)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
AREA STUDIES
CURRICULA (681, 682, 683, and 684)

Graduates of the area studies program will have a general understanding of U.S. policy objectives and the role of foreign policy in achieving them. They will then develop a thorough understanding of the particular region in which they specialize. Specifically, students will address the following topics while participating in the program:

GENERAL PLANNING ISSUES

U.S. Security Policy: The formulation and execution of U.S. national security policy and foreign policy, which is to include an analysis of international relations, and the instruments available to the U.S. Government to obtain its political and strategic objectives.

Military History and Defense Organization: The history of the American military including the origins and evolution of current U.S. strategy. Students must also understand the internal organizational structure of the U.S. defense establishment, and its relationship with the other components of the U.S. Government.

Military Strategy: Overview of Joint and Maritime Strategic Planning, U.S. maritime strategy and recent developments in naval warfare which enhance the ability of the U.S. to meet its strategic objectives.

Current Issues: The major security issues in the world including political and military conflicts, insurgencies and terrorism, social and economic problems, and other issues that affect the status of particular nations. These issues should be addressed in the context of their relationship to U.S. foreign and security policies.

SPECIFIC REGIONAL MATTERS

Culture and Religion: The influence of class structure and of ethnic, cultural and religious values on domestic and foreign affairs. This will include the origins of current cultural and religious structures and how these factors affect regional and national unity.

Economics: The economic strengths and weaknesses of the region, and the economic factors which influence political ideology, military doctrine, and industrial and social development. This will include familiarity with the economic structure of the region and its principal resources, industrial capacity, manpower availability trade issues, trade patterns and other economic elements of the particular region.

Geography: Geography and its impact on regional and national development, agriculture, transportation, economic sufficiency, military capability and general strategic posture.

Historical Development: A detailed knowledge of the historical developments of the particular region, with emphasis on the political evolution, traditional enemies and conflicts, regional alliances, and domestic issues.

Military Forces: The composition, structure, capabilities, vulnerabilities, roles and missions, and political influence of the armed forces of the region; current political and military developments, regional politico-military relations, and regional defense agreements.

Politics: Major political systems, political culture and governmental organizations, current political doctrine and issues, and the strength, appeal, and influence of Communism and other ideologies in the selected region. A detailed awareness of the current relationships, attitudes and perspectives toward both the United States and the Soviet Union prevalent in the area.

Strategic Posture: National and regional strengths and weaknesses that affect a nation's strategic postures and capabilities; major military, political, economic and sociological trends which affect policy choices in domestic and foreign affairs.

U.S. Military Strategy: U.S. Military Strategy for the selected region.

Soviet Military Strategy: Soviet Military Strategy for the selected region.

ADDITIONAL SKILLS

Writing Skills: The ability to write in a clear, concise manner, and to transform large quantities of information into short summaries which can be used by decision makers.

Briefing skills: The ability to present oral briefings in a clear, concise manner, transforming large quantities of information into short verbal summaries for key decision makers.

EDUCATIONAL SKILL REQUIREMENTS
STRATEGIC PLANNING/IO&N
CURRICULUM(688)

Graduates of this program will possess a firm understanding of the broad range of considerations involved in the formulation of U.S. national policy and military strategy. This will include an appreciation of the threats to the United States and its allies, the mechanics of U.S. policy formulation, the development and execution of military strategy, the components of that strategy and the assets available to meet national strategic objectives. Graduates will also possess an understanding of factors affecting international relations, and the role international organizations and negotiations play in achieving U.S. policy objectives. The following specific requirements will be addressed:

THREATS

The Soviet Union: A thorough understanding of the Soviet Union to include the historical development of the Soviet State and the Warsaw Pact; the relationship of Soviet political, economic and military doctrine; Soviet political and military involvement in the third world nuclear and conventional military doctrine and strategy; Soviet role in nuclear proliferation; Soviet resources and mobilization potential; and a net assessment of U.S./U.S.S.R. economic and military strength.

Other threats: An appreciation for other threats to U.S. interests and those of its allies, which should include such issues as Middle East confrontations, the Arab/ Israeli conflict, and the growth of international terrorism; threats in the Pacific including North Korea, China, and Vietnam; instability in Latin America and Africa; the proliferation of nuclear, chemical, and biological weapons; missile technology proliferation; and other issues of contemporary concern.

FORMULATION OF U.S. POLICY

The formulation of U.S. National Security Policy and Foreign Policy. This should address the role of the President, NSC, intelligence organizations, Congress, State Department, Department of Defense, JCS, and interagency groups in policy formation; the range of measures available to the U.S. to meet its policy objectives, such as arms control agreements, security assistance, membership in international organizations, bilateral diplomacy, and application of military power.

DEVELOPMENT AND EXECUTION OF MILITARY STRATEGY

American and world military history, joint and maritime strategic planning, including the origins and evolution of national and allied strategy; current American and allied military strategies which address the entire spectrum of conflict; the U.S. Maritime Component of National Military Strategy; the organizational structure of the U.S. defense establishment; the role of the Commanders of Unified and Specified Commands in strategic planning; the process of strategic planning; joint and service doctrine, and the roles and missions of each in meeting national strategy.

MILITARY ASSETS AVAILABLE TO MEET NATIONAL OBJECTIVES

Nuclear Forces: U.S. nuclear capabilities and doctrine including capabilities of each service; current and projected Soviet nuclear capabilities and doctrine; current and projected capabilities of China, France, the United Kingdom and Third World countries; basic nuclear weapon allocation and application theory including weapon foot-printing, nuclear planning factors and the targeting process (SLOP and TNF) at JSTPS, Dahlgren, etc.

Space Forces: Development of SDI including doctrine for use, potential capabilities, and economic, political and technological restraints; ASAT and other military applications of space; launch capabilities and support issues of the U.S. space program.

Chemical and Biological Weapons: Doctrine regarding the use of chemical and biological weapons, global balance of these weapons, treaties regarding their production and employment, and history of their use.

Logistics: Mobilization capability of the U.S. and its allies including the adequacy of their industrial bases, natural resource supplies, reserve forces, sealift and airlift, etc., to meet strategic planning objectives; the role of mobilization in deterrence and the importance of logistics throughout the planning process.

Conventional Forces: U.S. conventional capabilities with emphasis in naval forces and recent developments in naval warfare.

NONMILITARY INSTRUMENTS OF NATIONAL STRATEGIES

Technology: The role of technology in the development of defense strategy and the implication for national security.

Economics: Implications of U.S. defense budgets on the American economy, political factors involved in the formulation of the defense budget and the mechanics of the defense budgeting process (PPBS).

Intelligence: U.S. intelligence resources, methodologies and reliability.

Diplomacy: Use of negotiations, trade agreements and other diplomatic measures to achieve national objectives.

DEVELOPMENT AND SUBSTANCE OF THE INTERNATIONAL POLITICAL

An understanding of the evolution of the current international structure including the cultural, economic, and strategic foundations such as technological advances, resource shortfalls, economic interdependencies and military balance.

COMPONENTS OF INTERNATIONAL NEGOTIATIONS

International Law: The rudiments of international law including law of the sea and the laws of war.

Arms Control: The foundation and mechanics of bilateral and multilateral arms control efforts, and the implications on American strategy and the global political structure.

Alliances: U.S. involvement in alliance relationships including a thorough understanding of the history and substance of NATO, and U.S. alliances with Japan and Korea. In addition, an appreciation for other alliances such as the Organization of American States, the ANZUS Treaty and agreements with the Philippines, Thailand, etc.

Military Power: An overview of the world's military balance and the history of the use of military power in achieving national political objectives.

Security Assistance: The use of security assistance to achieve political and strategic objectives, and the problems associated with it.

CULTURE, RELIGION AND IDEOLOGY
The influence of class structure and of national, ethnic, cultural and religious values on domestic and foreign affairs, and the influences these factors have on international negotiations and the formulation of U.S. foreign policy.

CURRENT INTERNATIONAL ISSUES
The major current issues in the world including social and economic problems, human rights, transnational issues (drugs, environment, population, etc.) and other issues that affect the status of nations and may have an impact on or threaten the interests of the U.S. and its allies. These issues should be addressed in the context of their relationship to U.S. foreign and security policies.

ADDITIONAL SKILLS
Writing skills: The ability to glean the key points from complex issues and to write in a clear, concise manner, providing top decision makers with essential information.

Briefing skills: The ability to present oral briefings in a clear, concise manner, breaking out the essential information for top decision makers to act on complex issues.

EDUCATIONAL SKILL REQUIREMENTS
SPECIAL OPERATIONS AND LOW INTENSITY CONFLICT
CURRICULUM (699)

Graduates of this program will possess a firm understanding of the broad range of factors involved in the phenomenon of low intensity conflict and the structures and processes utilized by the U.S. and other countries to deal with it. This will include an appreciation of the multitude facets of the causes and consequences of different forms of political violence, ranging from terrorism to mid-level conflict and comparative examples from contemporary experience as well as history. The structures and processes of the American and other systems of national defense, and the decision-making systems pertaining to special operations, are central to this program. An understanding of the military and non-military roles of the U.S. and other armed forces.

ORGANIZATION AND FORMULATION OF U.S. SECURITY POLICY
The formulation of U.S. national security policy and foreign policy including the role of the President, NSC, Congress, State Department, Department of Defense, JCS, and interagency groups in policy formulation; the organization, resources, methodologies and reliability of U.S. intelligence capabilities; the range of measures available to the U.S. to meet its policy objectives including the application of military power, bilateral diplomacy, security and economic assistance, participation in multilateral organizations and coalition building.

DEVELOPMENT AND EXECUTION OF MILITARY STRATEGY
American and World military history, including the origins and evolution of national strategy and that of selected other countries; current strategies of the U.S., allies and potential aggressors which address the entire spectrum of conflict; and, the maritime dimension of U.S. national military strategy. The organizational structure of the U.S. defense establishment, role of the commanders of the unified and specified commands in planning and execution of strategy, process of strategic planning, service and joint doctrine and the roles and missions of all significant components in meeting national strategy.

GLOBAL AND COMPARATIVE ECONOMIC ANALYSIS
The main concepts and relevant data on global economics. Implications of defense budgets for the American economy, political and other factors involved in the formulation of the defense budget, and the mechanics of the defense budgeting process (PPBS). Comparison and contrast of the factors which promote or impede economic development; analysis of the economic might of different countries and regions; and the role of foreign involvement in economic growth.

TERRORISM AND OTHER FORMS OF UNCONVENTIONAL WARFARE
An examination of the origins, nature and political/military roles of contemporary international terrorism. A review of the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, different types of terrorism and the challenge international terrorism poses for American interests. Comparison and contrast of possible responses to terrorism, including military responses.

HISTORICAL AND CONTEMPORARY CASES OF SPECIAL OPERATIONS
An understanding of historic and contemporary Special Operations (SO), including the planning, organization, training, equipping and employment of SO forces in World War II, Korea, Vietnam, Grenada, Panama and Southeast Asia. An analy-

sis of why these forces were used and how their employment affected the military and political outcome for the U.S. and other countries.

COMPARATIVE CASES OF AND RESPONSES TO LOW INTENSITY CONFLICT
A review of contemporary and historical low intensity conflict issues in Latin America, the Middle East and Asia. A focus on the pertinent theoretical literature on political violence in the regions, review of the recent history of regionally-based terrorism and insurgency, a series of detailed case studies of local organizations and conflict, and focus on functional issues of particular concern in the region under investigation including drugs in Latin America and religious sources of violence in the Middle East.

CONTINGENCY OPERATIONS AND MID-LEVEL CONFLICT
An understanding of the history and current role of (a) military force as a political instrument and (b) contingent intervention in U.S. foreign policy; includes an examination of the nexus between unconventional and conventional warfare concepts and capability including deterrence and peacetime engagement. A review of the political and signalling role of military forces, most notably naval forces, short of war. Includes principles and concepts underlying the non-lethal employment of military power, the functions these actions are designed to serve, and the historical record of American efforts at "armed diplomacy." The latter includes the history of U.S. armed intervention in the Third World from Lebanon (1958) through Operation Just Cause (1989) and U.S. involvement in contingent operations from the Mayaguez action (1975) through the evacuation of citizens from Liberia (1990). Examination of the special decision making problems posed by the need for unanticipated military action in the face of often unclear goals and information.

NON-MILITARY ROLES OF THE ARMED FORCES
The diverse political roles played by the military and paramilitary establishments in the Third World. Comparative analysis of character of Third World civil-military relations, and the pressures, motivations and consequences of military coups against established governments. Relationship between national political culture and military intervention and the varying methods and degrees of intervention. Different types of military governments, consequences of military rule for national stability, problems inherent in transition to civilian rule and consolidation of democratic regimes.

JOINT AND MARITIME STRATEGIC PLANNING
Provides graduate level understanding of the development and execution of military strategy and effects of technical developments on warfare and the formulation of U.S. policy; roles of military forces, joint planning; and current issues in defense reorganization.

EDUCATIONAL SKILL REQUIREMENTS
INTELLIGENCE
CURRICULUM (825)

Graduates of the intelligence curricula will have a thorough understanding of the U.S. Intelligence Community and its current and future operations; a general understanding of the scientific and technological factors which bear on intelligence; a general understanding of the use of computers in intelligence; and a general understanding of the Soviet Union and the role of its military, particularly the Soviet Navy. Additionally, graduates will have a thorough understanding in one of three aspects of intelligence in which they specialize: (1) Emphasis on the Soviet Union (XX18); (2) Emphasis on Science and Technology (XX17); or (3) Emphasis on Operational Intelligence (XX19).

PROFESSIONAL DEVELOPMENT

CORE FOR INTELLIGENCE

THE U.S. INTELLIGENCE COMMUNITY: A basic knowledge of the organization and functioning of the intelligence community; its structure and terminology; the intelligence cycle to include the processes by which requirements are derived and raw information is converted into finished intelligence; the workings of military and naval intelligence and the applicability of intelligence to military and naval operations; a basic knowledge of current intelligence systems and products, their strengths and weaknesses; the C3I architecture and future systems; threat analysis to include methods for quantifying, forecasting and assessing significance, the effects of cultural and organizational biases on threat analysis, and lessons learned from case studies.

SCIENTIFIC AND TECHNOLOGICAL FACTORS OF INTELLIGENCE: A basic appreciation of the scientific and technological factors which bear on the intelligence processes of both the U.S. and the U.S.S.R. to include the effects of the environment and types of acoustic detection devices related to submarine detection; the types of equipment and environmental effects related to communications, communications intercept and other electronic systems; aerodynamic and other physical aspects of missile, aircraft and space systems design particularly as related to use of space for intelligence purposes; weapons as systems and the factors which determine their characteristics, capabilities and effectiveness.

THE USE OF COMPUTERS IN INTELLIGENCE: A basic knowledge of the capabilities and limitations of computers and the applications of computers to intelligence to include familiarity with computer-related terminology, elements of computer languages and programming, interface between man and computer, and trends in computer development; the characteristics of computer accessed intelligence data bases and applications of the computer to manipulating and displaying data, performing quantitative analyses, and solving problems.

THE SOVIET UNION AND THE ROLE OF ITS MILITARY: Knowledge of the National Security Objectives of the Soviet Union. A basic knowledge of the structure of the Soviet society and government, of Marxist-Leninist philosophy, of the Soviet process for formulating and implementing national security objec-

tives and policies, of the factors affecting that process, of the structure and purpose of the Soviet military and its strengths and limitations. A working knowledge of the basic tenets of Soviet military doctrine and strategy, the Soviet military mind-set; contrasts with U.S. military thought and strategy, the impact of geographical, historical, ethnic, political and economic influences a basic understanding of the process of weapons design, development and testing with application to technological forecasting, the role of the Soviet Navy in overall Soviet military strategy, the Soviet military establishment as an expression of Soviet national objectives and aspirations. A working knowledge of the composition, capabilities and limitations of the Soviet Navy; its doctrine and strategy; its utilization in peacetime and war; its missions and functions: projections for its future role and capabilities; comparisons with Western maritime capabilities; relationship of the Navy to the merchant marine and fishing fleets and other related maritime endeavors.

ANALYTICAL TOOLS: A working knowledge of basic research techniques including sources of open source and classified information, of how to retrieve and analyze information for various purposes (net assessments, forecasts, gaming, simulation, modeling), of how to use basic analytical tools such as time lines and graphic displays and of how to present findings in both written and oral form: a working knowledge of the analytical tools, including basic mathematics, needed for successful completion of probability and statistics, operations analysis and computer applications courses, as well as for understanding acoustic signal propagation, electromagnetic signal propagation, information processing and engineering design practices; a basic knowledge of other quantitative techniques applicable to problem solving in intelligence.

AREAS FOR SPECIALIZED STUDY

EMPHASIS ON THE SOVIET UNION (PLUS RUSSIAN LANGUAGE STUDIES AT DLI): A thorough understanding of the culture, religion, economy and history of the Soviet Union, and how these factors have shaped the political, military and social structures of the nation as well as influenced its foreign relations, including how the development of the Soviet Union has heavily influenced the foreign and domestic policies of Europe and Asia; a thorough understanding of the Soviet Navy and, in particular, how these factors have shaped the decision-making process of that organization.

EMPHASIS ON SCIENCE AND TECHNOLOGY: A basic knowledge of acoustics to include acoustic propagation in seawater, acoustic detection systems and their properties, and the effects of oceanographic and other related factors on submarine detection, a basic knowledge of electromagnetic theory necessary to understand communications and radar systems; a basic knowledge of the principles and applications of communication, signal intercept, and other electronic systems to include their capabilities and limitations, the impact of the environment, electronic countermeasures, and other factors on their operation, and the development and application of such systems by the Soviet Union; a basic knowledge of the aerodynamics and physics applying to the design and functioning of aircraft, missile and space systems to include an appreciation of the potential uses of space platforms for intelligence and other military purposes; and a basic understanding of the interdependence of weapons systems, of the tradeoffs which can be made within and between systems and techniques for measuring the characteristics, capabilities and effectiveness of weapons systems.

EMPHASIS ON OPERATIONAL INTELLIGENCE: A thorough understanding of the role of operational intelligence throughout the spectrum of conflict (global strategic war, crisis management, protracted low intensity conflict, terrorism), of the factors which dictate a varying intelligence approach in each phase, and of how these factors have been illustrated in case studies of past national crises; a working knowledge of collection management and the use of national, theater and tactical intelligence collection and processing systems (human/imagery/signal intelligence, etc.) for operational intelligence support throughout the spectrum of conflict; an in-depth understanding of today's Soviet Navy, and in particular, the decision-making process of that organization; an acquaintance with operations research approaches and methods, particularly as applied to intelligence and to the emphasis placed on operations research by the Soviet military; an acquaintance with foreign counterintelligence including measures for detection, counteraction and prevention of espionage, sabotage, terrorism and assassinations.

NAVAL ENGINEERING PROGRAMS

Curricular Officer:
Walter A. Ericson
CAPT, USN
Code 34, Halligan Hall
Room 220
(408) 656-2033
DSN 878-2033

NAVAL ENGINEERING PROGRAMS
CURRICULUM 570

The objective of this program is to provide graduate education, primarily in the field of Mechanical Engineering. The graduate will have the technical competence to operate and maintain modern warships and naval systems. He or she will be able to participate in technical aspects of naval systems acquisition for technological advances in naval ships and systems. Through emphasis on the design aspect within the program, the graduate will be well prepared to apply these advances in technology to the warships of the future. An original research project resulting in a finished thesis is an integral part of the curriculum. The schedule of classes is arranged to provide time during the final two quarters for concentration in this area of specialization.

REQUIREMENTS FOR ENTRY

A baccalaureate degree or its equivalent is required, preferably in an engineering discipline. A minimum academic profile code (APC) of 323 (334 via Engineering Science Curriculum 460) is required. This equates to a minimum grade point average of 2.20, with mathematics through differential and integral calculus and one year of calculus-based physics as non-waiverable requirements. The program is open to naval officers in the rank of LTJG through LCDR in the 11XX/14XX community, equivalent grade officers of other U.S. services and qualified foreign military officers. DoD employees are also eligible. Current enrollment is approximately 135 students.

NAVAL ENGINEERING SUBSPECIALTY

Completion of this curriculum qualifies an officer as a Naval Engineering Specialist with a subspecialty code of XX54P. The curriculum sponsor is Naval Sea Systems Command. A limited number of particularly well qualified students may be able to further their education beyond the Master's Degree and seek the degree of Mechanical Engineer and a XX54N Subspecialty Code.

TYPICAL SUBSPECIALTY ASSIGNMENTS

Upon award of the XX54P subspecialty code, the officer becomes eligible for assignment to those billets identified as requiring graduate education in Naval Engineering. Typical of these billets are the following:

Industrial Activities - Shipyard, SUPSHIP, Ship Repair Facility
Mechanical Engineering Instructor, USNA
Tender Repair Officer (Engineering Duty Officer)
Fleet/Type Commander Staff
Board of Inspection and Survey
Propulsion Examining Board
SIMA

ENTRY DATES

Naval Engineering is an eight-quarter course of study for a 11XX officer and a nine-quarter program for a 14XX officer with entry dates four times per year. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 570
Academic Associate:
Morris Driels, Professor
Code ME/DR, Halligan Hall, Room 207A
(408) 656-3383, DSN 878-3383

DEGREE
Requirements for the degree Master of Science in Mechanical Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

NS3252	(4-0)	Joint and Maritime Strategic Planning
MA1118	(5-2)	Multivariable Calculus
ME2501	(3-0)	Statics
MA1042	(2-0)	Matrix Algebra

Quarter 2

MA2121	(4-0)	Ordinary Differential Equations
ME2502	(4-1)	Dynamics
ME2601	(3-2)	Mechanics of Solids I
ME2101	(4-1)	Thermodynamics

Quarter 3

ME2201	(3-2)	Introduction to Fluid Dynamics
ME2801	(3-2)	Introduction to Engineering Systems
ME2440	(3-0)	The Digital Computer as an Engineering Tool
ME2441	(0-2)	Engineering Computational Laboratory
MA2049	(3-0)	Vector Analysis with Applications

Quarter 4

ME3150	(4-2)	Heat Transfer
ME3201	(3-2)	Intermediate Fluid Mechanics
ME3801	(3-0)	Linear Automatic Controls
ME3802	(0-2)	Controls Laboratory
MA3132	(4-0)	Partial Differential Equations and Integral Transforms

Quarter 5

ME3611	(4-2)	Mechanics of Solids II
ME3711	(4-1)	Design of Machine Elements
MS3201	(3-2)	Materials Science
MA3243	(4-1)	Numerical Methods for Partial Differential Equations.

Quarter 6

ME3240	(3-0)	Reciprocating and Gas Turbine Power Plants
ME3241	(0-3)	Power Plants Laboratory
ME3521	(3-2)	Mechanical Vibrations
MS3202	(3-2)	Failure Analysis
ME2301	(3-1)	Introduction to Naval Architecture.

Quarter 7

EC2170	(4-2)	Electrical Engineering Fundamentals
ME3410	(2-4)	Mechanical Engineering Laboratory
ME3220		Elective
OS3104	(4-0)	Statistics for Science and Engineering

Quarter 8

ME0810	(0-0)	Thesis Research
ME0810	(0-0)	Thesis Research

EC2270		Elective
ME4XXX		Elective

Quarter 9

ME0810	(0-0)	Thesis Research
ME0810	(0-0)	Thesis Research
ME4XXX		Elective
ME4XXX		Elective

TOTAL SHIP SYSTEMS ENGINEERING

The objective of this program is to provide a broad-based, design oriented education focusing on the warship as a total engineering system including hull, mechanical, electrical and combat systems. The program is for selected Naval Engineering students and is structured to lead to the degree of Mechanical Engineer, in addition to the MSME. The program includes a six-week experience tour at design-oriented organizations intended to enhance the design aspect of the program. Similar programs are available through the Weapons Engineering Program and the Electronic and Communications Program leading to the Mechanical Engineer or Electrical Engineer degrees. Entry to the program is through the standard 530/570/590 curricula.

REQUIREMENTS FOR ENTRY

A baccalaureate degree in an engineering discipline is required, with an APC of 222. Students are expected to be capable of validating several undergraduate courses included in the standard 570 program. The program is open to Naval officers in the rank of LTJG through LCDR in the 11xx/14xx communities.

NAVAL ENGINEERING SUBSPECIALTY

Completion of this program will lead to a subspecialty code of xx54N (or xx55N if entered from the Electronics and Communications Program.)

Typical Jobs in this Subspecialty:

Upon award of xx54N (or xx55N) subspecialty code the officer would be eligible for assignments typical of the P-Code. The expectation is that the combination of education and experience would lead to individuals qualified for assignment later in their career to more responsible positions in systems design and acquisition in NAVSEA, SPAWAR and OPNAV, and as Program Managers.

ENTRY DATES

Total Ship Systems Engineering is an eleven-quarter program with an entry date of October. If further information is needed, contact the Curricular Officer or the Academic Associate for this curriculum.

Curriculum
Academic Associate:
None assigned at time of catalog printing
Code ME/, Halligan Hall
(408)656-3425, DSN 878-3425

DEGREE

Requirements for the degrees of Mechanical or Electrical Engineer and Master of Science in Mechanical or Electrical Engineering are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA2121	(4-0)	Ordinary Differential Equations
EC2170	(4-2)	Introduction to Electrical Engineering
ME2101	(4-1)	Engineering Thermodynamics
ME2201	(3-2)	Introduction to Fluid Mechanics

Quarter 2

MA3132	(4-0)	Partial Differential Equations
ME3521	(3-2)	Mechanical Vibrations
ME3201	(3-2)	Intermediate Fluid Mechanics
ME2601	(3-2)	Mechanics of Solids I

Quarter 3

ME3220	(3-2)	Auxiliary and Turbomachinery
MS3201	(3-2)	Materials Science and Engineering
ME2801	(3-2)	Introduction to Engineering System Dynamics
ME3611	(4-0)	Mechanics of Solids II

Quarter 4

EC2270	(4-2)	Basic Electronic and Electrical Machines
ME3801	(3-0)	Linear Automatic Controls
ME3802	(0-2)	Controls Laboratory
TS3001	(3-2)	Fundamental Principles of Naval Architecture
ME3150	(4-1)	Heat Transfer

Quarter 5

TS3000	(3-2)	Electrical Power Engineering
ME3440	(4-0)	Engineering Analysis
ME3711	(4-1)	Design of Machine Elements
MS3202	(3-2)	Failure Analysis and Prevention

Quarter 6

TS3002	(3-2)	Principles of Ship Design and Case Studies
TS3003	(4-0)	Naval Combat Systems
ME3240	(3-0)	Reciprocating and Gas Turbine Power Plants
ME3241	(0-3)	Power Plants Laboratory
OS3104	(4-0)	Statistics for Science and Engineering

Quarter 7

TS3005	(2-4)	Naval Combat Systems Design
TS4001	(2-4)	Design of Naval Engineering Subsystems
ME3410	(2-4)	Mechanical Engineering Instrumentation and Measurement Lab
ME4XXX		Elective

Quarter 8

ME0810	(0-0)	Thesis Research
		Experience Tour

Quarter 9

TS4002	(3-2)	Comparative Advanced Design Concepts
ME4XXX		Elective
ME0810	(0-0)	Thesis Research
ME0810	(0-0)	Thesis Research

Quarter 10

TS4003	(2-4)	Total Ship Systems Engineering
ME4XXX		Elective
ME0810	(0-0)	Thesis Research
ME0810	(0-0)	Thesis Research

Quarter 11

NS3252	(4-0)	Joint and Maritime Strategic Planning
ME4XXX		Elective
ME0810	(0-0)	Thesis Research
ME0810	(0-0)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
NAVAL ENGINEERING
CURRICULUM (570)

Officers entering into the Naval Engineering curriculum will be offered the necessary preparatory level courses to enable them to satisfy the equivalent of a baccalaureate degree in Mechanical Engineering, if they do not have such an accredited degree. They shall meet, as a minimum, the requirements set forth by the Accreditation Board for Engineering and Technology (ABET).

At the graduate level, the officer will acquire the competence to participate in technical aspects of naval systems research, development, maintenance and acquisition. The background to deal with future advances is gained through the emphasis on design and a combination of the core program requirements, specialization and thesis research.

In pursuit of the above, the goal is for each officer to acquire a senior/upper division level physical and analytical understanding of the following topics. It is recognized that all students may not meet all ESRs depending on individual circumstances determined by the curricular officer and the academic associate. However, each student will be exposed to fundamentals in all ESR areas.

THERMODYNAMICS AND HEAT TRANSFER: Thermodynamics and heat transfer/conversion particularly as applied to nuclear and fossil fuel power plants, shipboard engineering power cycles, marine diesel/gas turbine propulsion and auxiliary systems.

FLUID MECHANICS: Inviscid flow and compressible and incompressible viscous flow, with emphasis on propellers, cavitation, and design of shipboard fluid systems (e.g., fluid machinery, pumps, turbomachinery).

DYNAMICS/STRUCTURAL MECHANICS: The motion of bodies with emphasis in control systems, static and dynamic behavior of statically determinant and indeterminant structures, stress/strain distributions; buckling and cyclic loads; effects of shock loading vibration and structural damping, with emphasis on the application of the foregoing to the structure of ships.

MATERIALS AND FABRICATION: Metallurgical processes and transformations; analytical approach to failure of materials in Naval Engineering use and a basic understanding of the materials technology associated with welding and marine corrosion; and introduction to the developing fields of composites and superconducting materials.

COMPUTERS: A basic understanding of computer software (for PC's, work stations and mainframe computers), emphasizing programming of engineering problems of particular interest to the Navy.

MATHEMATICS: Sufficient mathematics, including integral transforms and numerical analysis, to achieve the desired graduate education.

DESIGN/SYNTHESIS: Design synthesis and introduction to optimization techniques, with emphasis on the design of mechanical subsystems and their integration into the ship system.

ELECTRICAL ENGINEERING: Electromagnetic and circuit theories, basic knowledge of analog and digital circuits, rotating electrical machinery, static converters and power distribution systems and multiphased circuits. A basic understanding of automated control systems and their application to mechanical equipment, integrated electrical machinery, electric power transmission and superconductors.

NAVAL ARCHITECTURE: A basic understanding of Naval Architecture, including ship hydrodynamics and key elements of Naval construction and repair.

DECISION MAKING, RELIABILITY ASSESSMENT AND QUALITY CONTROL: A basic knowledge of concepts and applications for decision making, reliability, prediction and assessment and quality control. A practical understanding of relevant probability theory including statistical data analysis techniques, probability distribution and characteristics and standard tests. An understanding of Maintenance Engineering concepts such as reliability, maintainability and availability.

SPECIALIZATION: Each officer will also acquire technical competence in one or more of the following areas: THERMAL/FLUID SCIENCES, STRUCTURES, DYNAMICS AND CONTROLS, OR MATERIAL SCIENCE, through additional graduate level courses and their associated prerequisites.

JOINT AND MARITIME STRATEGIC PLANNING: Joint and Maritime Strategic Planning to include development and execution of military strategy and the effects of technical developments on warfare, formulation of U.S. policy, roles of military forces, joint planning and current issues in defense reorganization.

CONDUCT AND REPORT INDEPENDENT RESEARCH: Each officer will have the ability to conduct independent research in the general area of Naval Engineering by resolving the questions encountered and presenting the results of the investigation in both written and oral form.

OPERATIONS ANALYSIS PROGRAMS

Curricular Officer:
Alan Zimm
CDR, USN
Code 30, Root Hall
Room 232
(408) 656-2786
DSN 878-2786

OPERATIONS ANALYSIS CURRICULUM 360

This program provides education in the application of quantitative analyses to operational, tactical and managerial problems. Mathematics, probability, statistics, economics, human factors, physical science and optimization supply the theoretical background for analyzing alternative choices in tactical and strategic warfare, and in planning, budgeting and procurement of systems and forces. The student learns computational methods and develops skills to identify relevant information, formulate decision criteria and select alternatives. This education enhances performance in all duties throughout a military career including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades in mathematics is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students and there are other indicators of potential such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program. An APC of 324 is required.

OPERATIONS ANALYSIS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Analysis Subspecialist with a subspecialty code of XX42P. The curriculum sponsor is OP-81, Program Resource Appraisal Division.

Typical Jobs in this Subspecialty:
Destroyer Squadron Chief Staff Officer
OPNAV Air Warfare Program Analyst
JCS Analyst
Director OPS Research: SACLANT
Assistant Staff OPS/PLANS: COMCARGRU
Staff OPS and PLANS: COMTHIRDFLT

ENTRY DATES

Operations Analysis is an eight-quarter course of study with entry dates in April and October. If further information is needed, contact the Academic Associate or the Curricular Officer for this curriculum.

Curriculum 360
Academic Associate:
James D. Esary, Professor
Code OR/Ey, Root Hall, Room 273
(408) 656-2780, DSN 878-2780

DEGREE

Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

OA2200	(4-1)	Computational Methods for Operations
MA1118	(5-2)	Multivariable Calculus
MA2042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2

OA3200	(4-0)	Computational Methods for Operations Research III
MA3110	(4-0)	Topics in Intermediate Analysis
NS3252		Joint & Maritme Strategic Planning
OA3102	(4-1)	Probability and Statistics

Quarter 3

OA3201	(4-0)	Linear Programming
OA3401	(4-0)	Human Factors in Systems Design I
OA3301	(4-0)	Stochastic Models I
OA3103	(4-1)	Statistics

Quarter 4

OA4202	(4-0)	Network Flows and Graphs
OA4604	(4-0)	War Gaming Analysis
OA3302	(4-0)	Systems Simulation
OA3104	(3-1)	Data Analysis

Quarter 5

(First six weeks)		
OA4201	(4-0)	Non-Linear Programming
AS3610	(4-0)	Economics Analysis and Operations Research
(Last six weeks)		Experience Tour Off Campus

Quarter 6

OA3601	(4-1)	Combat Model and Games
OA3602	(4-0)	Search Theory and Detection
OA4301	(3-2)	Stochastic Models II
OA0810	(0-0)	Thesis Research

Quarter 7

OA4603	(3-2)	Test and Evaluation
OA0810	(0-0)	Thesis Research
OAXXXX		Elective
OA4702	(4-0)	Cost Estimation

Quarter 8

OA4602	(4-0)	Campaign Analysis
OA0810	(0-0)	Thesis Research
OAXXXX		Elective
OAXXXX		Elective

OPERATIONAL LOGISTICS
CURRICULUM 361

This program provides education in mathematics, probability and statistics, physical science, economics, logistics and computer science. These disciplines supply the theoretical background for analyzing alternative choices in Naval logistics planning, including sustainability of Naval Forces involved in long-range deployments.

The course of study develops skills in computational capability, identifying relevant information, generating decision criteria and selecting alternatives. This education enhances performance in all duties throughout a military career, including operational billets, technical management assignments and policy making positions.

REQUIREMENTS FOR ENTRY

A baccalaureate degree with above-average grades in mathematics is required. Completion of mathematics through single variable differential and integral calculus is considered minimal preparation. A one-year course in college physics is highly desirable. Students lacking these quantitative prerequisites will be accepted in cases where their undergraduate records indicate that they are exceptional students, and there are other indicators of potential, such as excellent Graduate Record Examination scores, correspondence or extension courses in quantitative subjects and outstanding motivation for the program.

OPERATIONAL LOGISTICS SUBSPECIALTY

Completion of this curriculum qualifies an officer as an Operations Logistics Subspecialist with a subspecialty of XX43P. The curriculum sponsor is OP-04, Office of Chief of Naval Operations (Logistics).

Typical Jobs in this Subspecialty:

ACOS, SACLANT
LOG, PLANS, CINCUSNAVEUR
LOG, PLANS, CINCPACFLT
OPNAV Fleet Mobilization
JCS Logistics
Warfare Analyst, NSURFWPC
OSD Analyst
USCINPAC Analyst
Head Special Studies, Strategic Systems Project Officer
VX-1 Analyst
War College Professor

ENTRY DATE

Operational Logistics is an eight-quarter course of study with a single entry date in October. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 361
Academic Associate:
David A. Schrady, Professor
Code OR/So, Root Hall, Room 225
(408) 656-2801, DSN 878-2801

DEGREE

Requirements for the degree Master of Science in Operations Research are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

OA2200	(4-1)	Computational Methods for Operations Research II
MA1118	(5-2)	Multivariable Calculus
MA2042	(4-0)	Linear Algebra
OA3101	(4-1)	Probability

Quarter 2

OA3200	(4-0)	Computational Methods for Operations Research II
MA3110	(4-0)	Topics in Intermediate Analysis
OA3610	(4-0)	Introduction to Naval Logistics
OA3102	(4-1)	Probability and Statistics

Quarter 3

OA3201	(4-0)	Linear Programming
MN4373	(4-0)	Transportation Management III
OA3301	(4-0)	Stochastic Models I
OA3103	(4-1)	Statistics

Quarter 4

OA4611	(4-0)	Logistics in Naval Warfare
OA3202		Simulation
OA3104	(3-1)	Data Analysis
OA4202	(4-0)	Network Flows and Graphs

Quarter 5

(First six weeks)		
OA4201	(4-0)	Non-Linear Programming Systems Simulation
AS3610	(4-o)	Micro Economics
(Last six weeks)		Experience Tour Off Campus

Quarter 6

OA3601	(4-1)	Combat Model and Games
OA3302	(4-0)	Systems Simulation
OA0810	(0-0)	Thesis Research
OA4612	(4-0)	Logistics Model

Quarter 7

OA4604	(4-0)	Wargaming Analysis
MN4310	(4-0)	Logistics Engineering
OA0810	(0-0)	Thesis Research
NS3252	(4-0)	Joint and Maritime Strategic Planning

Quarter 8

OA4602	(4-0)	Campaign Analysis
OA0810	(0-0)	Thesis Research
OA4302	(4-0)	Reliability
OAXXXX		Elective

ADVANCED SCIENCE (APPLIED MATHEMATICS) CURRICULUM 380

This program is designed to meet the needs of the Department of Defense for graduates who are skilled in the concepts of higher mathematics. The objective of the program is to equip an officer with the skill to: analyze a military problem; formulate it in mathematical terms; solve or approximate a solution; interpret and present the results.

Completion of this curriculum also qualifies an officer as an Applied Mathematics Subspecialist with a subspecialty code of XX41P. The curriculum sponsor is the U.S. Naval Academy Department of Mathematics. The typical job in this subspecialty is an instructor in mathematics at the U.S. Naval Academy or the U.S. Military Academy at West Point.

REQUIREMENTS FOR ENTRY

Preparatory to graduate work in applied mathematics, the officer shall have completed a strong program of study at the undergraduate level or the first three quarters of the mathematics core sequence, which includes linear algebra, advanced calculus in one and several variables, ordinary differential equations, probability and statistics. Officers not having the required qualifications for direct input enter the program indirectly through the Engineering Science curriculum discussed elsewhere in this catalog. An APC of 323 is required.

ENTRY DATES

Advanced Science (Applied Mathematics) is an eight-quarter course of study with entry dates in any quarter. If further information is needed, contact the Academic Associate or Curricular Officer for this curriculum.

Curriculum 380
Academic Associate:
Maurice D. Weir, Professor
Code MA, Ingersoll Hall, Room 335
(408) 656-2608, DSN 878-2608

DEGREE

Requirements for the degree Master of Science in Mathematics are met as a milestone en route to satisfying the Educational Skill Requirements of the curricular program.

TYPICAL COURSE OF STUDY

Quarter 1

MA1118	(5-2)	Multivariable Calculus
MA2089	(4-1)	Vector Analysis and Matrix Algebra
MA2042	(4-0)	Linear Algebra
MA0125	(3-0)	Introduction to Finite Mathematics

Quarter 2

MA2121	(4-0)	Ordinary Differential Equations
MA2025	(4-1)	Bridge to Advanced Mathematics
OA3101	(4-1)	Probabililty
OA2200	(3-2)	Computational Methods (FORTRAN or APL Programming)

Quarter 3

MA3110	(4-0)	Intermediate Analysis
MA3132	(4-0)	Partial Differential Equations
MA3232	(4-1)	Numerical Analysis
OA3102	(4-1)	Probability and Statistics

Quarter 4

MA3605	(3-0)	Fundamentals of Analysis I
MA4237	(4-0)	Advanced Numerical Analysis
MA3560	(3-0)	Modern Applied Algebra
OA3103	(4-1)	Statistics

Quarter 5

MA3606	(3-0)	Fundamentals of Analysis II
MA3243	(4-1)	Numerical Partial Differential Equations
MA3046	(4-1)	Advanced Linear Algebra
MA3730	(3-0)	Numerical Computation

Quarter 6

MA3400	(4-0)	Mathematical Modeling Processes
MA4611	(3-0)	Calculus of Variations
MA4391	(3-0)	Numerical Fluid Dynamics I
OA3201	(4-0)	Linear Programming

Quarter 7

MA3035	(2-1)	Microprocessors
NS3252	(4-0)	Joint and Maritime Strategic Planning
MS4392	(3-0)	Numerical Fluid Dynamics II
MA0810	(0-0)	Thesis Research

Quarter 8

		Elective
MA4300	(3-0)	Thesis Topics Seminar
MA0810	(0-0)	Thesis Research
MS0810	(0-0)	Thesis Research

TYPICAL COURSE OF STUDY (Applied Math Option)

Quarter 1

MA1118	(5-2)	Multivariable Calculus
MA2089	(4-1)	Vector Analysis and Matrix Algebra
MA2042	(4-0)	Linear Algebra
MA0125	(3-0)	Introduction to Finite Mathematics

Quarter 2

MA2121	(4-0)	Ordinary Differential Equations
MA2025	(4-1)	Bridge to Advanced Mathematics
OA3101	(4-1)	Probability
OA2200	(3-2)	Computational Methods (FORTRAN or APL Programming)

Quarter 3

MA3110	(4-0)	Intermediate Analysis
MA3132	(4-0)	Partial Differential Equations
MA3232	(4-1)	Numerical Analysis
OA3102	(4-1)	Probability and Statistics

Quarter 4

MA3605	(3-0)	Fundamentals of Analysis I
MA3400	(4-0)	Mathematical Modeling Processes
MA3560	(3-0)	Modern Applied Algebra
OA3103	(4-1)	Statistics

Quarter 5

MA3606	(3-0)	Fundamentals of Analysis II
MA3675	(3-0)	Complex Analysis I
MA3046	(4-1)	Advanced Linear Algebra
		Outside Elective I

Quarter 6

MA4622	(3-0)	Principles of Applied Mathematics I
MA3676	(3-0)	Complex Analysis II
MA4611	(3-0)	Calculus of Variations
		Outside Elective II

Quarter 7

MA4623	(3-0)	Principles of Applied Mathematics II
NS3252	(4-0)	Joint and Maritime Strategic Planning
		Outside Elective III
MA0810	(0-0)	Thesis Research

Quarter 8

MA4672	(3-0)	Integral Transforms
MA4300	(3-0)	Thesis Topics Seminar
MA0810	(0-0)	Thesis Research
MA0810	(0-0)	Thesis Research

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONS ANALYSIS
CURRICULUM (360)

JOINT AND MARITIME STRATEGIC PLANNING: The graduate will have a knowledge of development and execution of military strategy and the effects of technical developments on warfare, an understanding of the means of formulation of U.S. policy; the roles of military forces and joint planning, and current issues in defense organization.

DATA ANALYSIS: The graduate will be well-versed in probability and statistics and their applications to OR/SA problems.

Rationale: Uncertainty is a complicating factor in virtually all military operational problems. Probability and Statistics are the sciences developed to describe uncertainty. They provide the understanding for the identification, measurement and reduction of uncertainty.

OPTIMIZATION: The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

Rationale: A fundamental principle of analysis is to try to do better. The study of optimization encourages this approach to all problems and provides the tools for finding the best solution.

STOCHASTIC MODELING: The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and also be familiar with the major applications of such models.

Rationale: The prediction of the occurrence of events which are uncertain offers a powerful tool for solution of many problems in military operations.

HUMAN ENGINEERING: The graduate will be familiar with the man-machine interface and also will be able to quantify the limitations imposed on systems designed for use by human operators.

Rationale: Increasing technology places high demands on the human operator of military systems which may stress or overcome the individual's capability and/or training. The officer should understand this problem in order to effectively accomplish the unit's mission.

LOGISTICS: The graduate will be conversant with OR models in logistics areas.

Rationale: Military analysis for years was most highly developed in the logistical area. Concern for logistics remains an important facet of any officer's capability and is of overwhelming importance to supply corps officers.

WARFARE ANALYSIS: The graduate will be familiar with US/Allied and potential enemy capabilities, doctrine, and tactical concepts and will be able to model and analyze military operations using OR techniques, and be able to develop new tactical concepts based on theory and exercise reconstruction and analysis.

Rationale: The purpose of military operations research is to optimally apply the results of analysis to future operations. Analysis of tactical military operations include:

1) development of measures of effectiveness
2) design, reconstruction and evaluation of exercises
3) use of war-gaming and other simulation tools
4) modeling of tactical situation
5) knowledge and appreciation of weapon systems

SYSTEMS ANALYSIS: The graduate will understand the basic principles of economics and systems analysis as well as their application to various defense problems.

Rationale: Formulating decisions, or options, concerning budgeting and force planning are necessary in all DoD agencies. Proper resource allocation is the goal of the systems analyst working within these agencies.

BASICS: The graduate will:

a) possess the mathematical skills required to support graduate study in operations research;

b) have the ability to use the mainframe and microcomputer as a tool to aid in analysis; and

c) have been exposed to the basic physical and technological principles underlying the modern weapons systems.

Rationale: The basic skills are necessary for the accomplishment of the other methodologies presented in operations analysis.

PRACTICE: The graduate will have gained experience working on all aspects of an analytical study and will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

Rationale: The utilization of the newly acquired OR/SA skills in searching for a solution to a practical problem will reinforce the skills and enable the graduate to maintain a realistic perspective on problem solving and provide an appreciation of the difficulties of applying theory, as well as its power.

EDUCATIONAL SKILL REQUIREMENTS
OPERATIONAL LOGISTICS
CURRICULUM (361)

MODELING UNCERTAINTY: The graduate will be well-versed in probability and statistics and their applications to OR/SA problems.

Rationale: Uncertainty is a complicating factor in virtually all military operational problems. Probability and Statistics are the sciences developed to describe uncertainty. They provide the understanding for the identification, measurement and reduction of uncertainty.

JOINT AND MARITIME STRATEGIC PLANNING: The graduate will have a knowledge of development and execution of military strategy and the effects of technical developments on warfare; an understanding of the means of formulation of U.S. policy; the roles of military forces and joint planning; and current issues in defense organization.

OPTIMIZATION: The graduate will be able to formulate and solve a wide variety of optimization problems and also be conversant with the major uses of such models in DoD and the private sector.

Rationale: A fundamental principle of analysis is to try to do better. The study of optimization encourages this approach to all problems and provides the tools for finding the best solution.

STOCHASTIC MODELING: The graduate will be able to formulate and solve problems involving stochastic processes (processes with uncertainty over time) and also be familiar with the major applications of such models.

Rationale: The prediction of the occurrence of events which are uncertain offers a powerful tool for solution of many problems in military operation.

WARFARE ANALYSIS: The graduate will be familiar with US/Allied and potential enemy capabilities, doctrine, tactical and logistics support concepts and will be able to model and analyze military operations using OR techniques. He/she will further be able to develop new tactical and logistics concepts based on theory and analysis.

Rationale: The purpose of military operations research is to apply the result of analysis to military operations. Analysis of tactical military operations include:

1) Development of measures of effectiveness;
2) Design, reconstruction and evaluation of exercises;
3) Use of war-gaming and other simulation tools;
4) Modeling of tactical situation;
5) Knowledge and appreciation of weapon systems, and
6) Modeling and evaluation of afloat logistics.

SYSTEMS ANALYSIS: The graduate will understand the basic principles of economics and systems analysis as well as their application to various defense problems.

Rationale: Formulating decisions, or options, concerning budgeting and force planning are necessary in all DoD agencies. Proper resource allocation is the goal of the systems analyst working within these agencies.

BASICS: The graduate will:

a) possess the mathematical skills required to support graduate study in operations research;
b) have the ability to use the mainframe and microcomputer as a tool to aid in analysis.

Rationale: The basic skills are necessary to the accomplishment of the other methodologies presented in operations analysis.

TRANSPORTATION: The graduate will have an understanding of transportation systems and the constraints they place on operations, especially strategic airlift and sealift.

Rationale: Transportation systems accomplish the vital function of distribution in logistics systems and are thus of central importance in operational logistics.

LOGISTICS: The graduate will understand all aspects of the Navy logistics systems and Joint planning systems, and the use of analysis in all aspects of planning for deploying and sustaining forces at sea.

Rationale: The Navy mission to sustain combat forces at sea requires an extensive logistics support system. Knowing the logistics organizations and their functions in this system is required as a foundation for planning war time operation. Knowledge of the Joint Strategic Planning Systems (JSPS), Navy planning methods and analysis techniques is required to be effective in any logistics command, staff, or analysis position.

PRACTICE: The graduate will have gained experience working on all aspects of an analytical study in the field of operational logistics. Specifically, he/she will demonstrate the ability to conduct independent analytical studies and proficiency in presenting the results both orally and in writing.

Rationale: The utilization of the newly required OR/SA skills in searching for a solution to a practical problem will reinforce the skills and enable the graduate to maintain a realistic perspective on problem solving and provide an appreciation of the difficulties of applying theory as well as its power.

EDUCATIONAL SKILL REQUIREMENTS
APPLIED MATHEMATICS
CURRICULUM (380)

JOINT AND MARITIME STRATEGIC PLANNING: Development and execution of military strategy and effects of technical developments on warfare. Formulation of U.S. policy roles of military forces, joint planning and current issues in defense reorganization.

BASICS:

a) A solid foundation in linear algebra, calculus of one and several variables, ordinary differential equations, probability, statistics, discrete mathematics, modern applied algebra and mathematical modeling to support graduate study in mathematics;

b) Knowledge to use the mainframe and microcomputer as a tool to aid in analysis;

c) Exposure to the basic physical and technological principles underlying a diversity of real-world problems of importance to the military which the student may be called upon to model and analyze.

Fundamental Areas: An understanding, at the graduate level, of the following fundamental areas of mathematics;

probability
algebraic structures
numerical analysis
applied mathematics
mathematical modeling
linear algebra and vector analysis
real and complex analysis
ordinary differential equations
partial differential equations

Applications: Well-versed in the applications of mathematics to real-world problems of interest to the military. Areas of application include mechanical and electrical systems, stiffness and buckling of beams and plates, space systems and orbital problems, numerical computer problems associated with prediction errors, numerical weather prediction, ship routing, acoustics, wave propagation and robotics.

Computer Skills: A working knowledge of at least one higher level structured computer language and the operating system for a computer which supports that language. Be able to use the computer for numerical and symbolic computation of a wide variety of military and industrial problems.

PRACTICE: Have experience in organizing and presenting mathematical ideas, by oral and written means, to students and faculty. Includes, but is not limited to, the ability to present mathematics to students in a classroom environment.

DEPARTMENT OF ADMINISTRATIVE SCIENCES

Chairman:

David R. Whipple, Jr.,
Professor
Code AS, Ingersoll Hall
Room 229
(408) 656-2161
DSN 878-2161

Associate Chairmen:

Research
Stephen L. Mehay
Professor
Code AS/Mp, Ingersoll Hall
Room 246
(408) 656-2643
DSN 878-2643

Systems Development
Shu S. Liao
Professor
Code AS/Lc, Ingersoll Hall
Room 302
(408) 656-2505
DSN 878-2505

Instruction
Reuben T. Harris
Professor
Code AS/Hr, Ingersoll Hall
Room 242
(408) 656-2768
DSN 878-2768

Tarek Abdel-Hamid, Associate Professor of Management Information Systems (1986)*; PhD, MIT Sloan School of Management, 1984.

Rebecca J. Adams, CDR, SC, U.S. Navy, Instructor in Acquisition & Contracting (1992); MS, Naval Postgraduate School, 1987.

Frank J. Barrett, Assistant Professor of Organization and Management (1990); PhD, Case Western Reserve University, 1989; MA, University of Notre Dame, 1977; BA, University of Notre Dame, 1975.

Robert Barrios-Choplin, Adjunct Professor of Management (1991); MS, University of San Francisco, 1985.

Hemant K. Bhargava, Assistant Professor of Management Information Systems (1989); PhD, The Wharton School, University of Pennsylvania, 1990.

Dan Calvin Boger, Associate Professor of Economics (1979); PhD, University of California at Berkeley, 1979.

David G. Brown, Adjunct Professor of Transportation and Logistics (1991); PhD, University of Illinois at Urbana-Champaign, 1988.

Tung Xuan Bui, Associate Professor of Management Information Systems (1984); PhD, New York University, 1985.

Paul Marshman Carrick, Associate Professor of Emeritus (1969); PhD, University of California at Berkeley, 1956.

Alice Crawford, Adjunct Professor of Psychology (1988); MA, San Diego State University, 1973.

Daniel Roy Dolk, Associate Professor of Management Information Systems (1982); PhD, University of Arizona, 1982.

Richard B. Doyle, Associate Professor of Public Budgeting (1990); PhD, University of Washington, 1982.

Mark Jan Eitelberg, Associate Professor of Public Administration (1982); PhD, New York University, 1979.

Richard S. Elster, Dean of Instruction, Professor of Administrative Sciences (1969); PhD, University of Minnesota, 1967.

Kenneth J. Euske, Associate Professor of Accounting (1978); PhD, Arizona State University, 1978.

Roger Dennis Evered, Professor of Management (1979); PhD, University of California at Los Angeles, 1973.

James Morgan Fremgen, Professor of Accounting (1965); DBA, Indiana University, 1961.

Barry Albert Frew, Associate Professor of Information Systems (1984); MS, Naval Postgraduate School, 1984.

William R. Gates, Adjunct Professor of Economics (1988); PhD, Yale University, 1984.

William James Haga, Adjunct Professor of Management Information Systems (1988); PhD, University of Illinois, 1972.

Reuben T. Harris, Professor of Management (1978); PhD, Stanford University, 1975.

David Richard Henderson, Associate Professor of Economics (1984); PhD, University of California at Los Angeles, 1976.

Susan P. Hocevar, Adjunct Professor of Organization and Management (1990); PhD, University of Southern California, 1990; MA, Cornell University (1975); BA, University of Rochester (1970).

Thomas H. Hoivik, Adjunct Professor of Acquisition and Contract Management (1991); MA, Naval Postgraduate School, 1973; MS, Salve Regina University, 1988.

Fenn Clark Horton, Adjunct Professor of Economics (1964); PhD, Claremont Graduate School, 1968.

Carl Russell Jones, Professor of Information and Telecommunications Systems (1965); PhD, Claremont Graduate School, 1965.

Lawrence R. Jones, Professor of Financial Management and Budgeting (1987); PhD, University of California at Berkeley, 1977.

Louis Kalmar, CDR, U.S. Navy, Instructor in Financial Management (1992); MBA, Rensselaer Polytechnic Institute, 1988.

Magdi Nessim Kamel, Assistant Professor of Management Information Systems (1988); PhD, University of Pennsylvania, The Wharton School, 1988.

Keebom Kang, Adjunct Professor of Logistics (1988); PhD, Industrial Engineering, Purdue University, 1984.

David Vincent Lamm, Associate Professor of Acquisition and Contract Management (1978); DBA, George Washington University, 1976.
Shu Sheng Liao, Professor of Accounting (1977); PhD, University of Illinois, 1971.

Jerry Lee McCaffery, Professor of Public Budgeting (1984); PhD, University of Wisconsin, 1972.

Martin J. McCaffrey, Adjunct Professor of Contracting and Acquisition and Management Information Systems (1988); MS, Naval Postgraduate School, 1985.

Alan Wayne McMasters, Professor of Operations Research and Administrative Sciences (1965); PhD, University of California at Berkeley, 1966.

Stephen Louis Mehay, Professor of Labor Economics (1985); PhD, University of California at Los Angeles, 1973.

Carol Ann Mitchell, LCDR, U.S. Navy, Instructor in Manpower, Personnel, & Training Analysis (1991); MS, Naval Postgraduate School, 1984.

Thomas Preston Moore, Assistant Professor of Management Science (1986); PhD, Virginia Polytechnic Institute and State University, 1985.

Orrin Douglas Moses, Associate Professor of Accounting (1985); PhD, University of California at Los Angeles, 1983.

Jeffrey Nevels, LCDR, U.S. Navy, Instructor in Financial Management (1991); MBA, Xavier University, 1985.

Kenneth L. Orloff, Adjunct Research Professor of Management (1992); MS, Naval Postgraduate School, 1981.

Walter E. Owen, LCDR, U.S. Navy, Instructor in Acquisition Management (1992); MS, Naval Postgraduate School, 1992.

Balasubramaniam Ramesh, Assistant Professor of Information Systems (1990); PhD, New York University, 1992.

Benjamin J. Roberts, Associate Professor of Management and Human Resource Development (1985); PhD, Pennsylvania State University, 1977.

Nancy Charlotte Roberts, Associate Professor of Strategic Management (1986); PhD, Stanford University, 1983.

Joseph Girard San Miguel, Professor of Accounting (1982); PhD, University of Texas, 1972.

Norman Floyd Schneidewind, Professor of Information Sciences (1971); DBA, University of Southern California, 1966.

Kishore Sengupta, Assistant Professor of Management Information Systems (1989); PhD, Case Western Reserve University, 1990.

Sterling D. Sessions, Adjunct Professor (1989); PhD, Harvard University, 1962.

William Short, LCDR, U.S. Navy, Instructor in Management Information Systems (1992); MS, Naval Postgraduate School, 1983.

James Edward Suchan, Associate Professor of Management Communications (1986); PhD, University of Illinois, 1980.

Myung Suh, Assistant Professor of Management Information Systems (1989); PhD, University of Rochester, 1989.

Donald E. Summers, LtCol, U.S. Marine Corps, Instructor in Financial Management (1989); MS, Naval Postgraduate School, 1985.

Katsuaki Terasawa, Adjunct Professor of Economics and Policy Analysis (1989); PhD, University of Kansas, 1971.

Gail Fann Thomas, Associate Professor of Management Communications (1989); EdD, Arizona State University, 1986.

George William Thomas, Associate Professor of Economics (1978); PhD, Purdue University, 1971.

Kenneth W. Thomas, Professor of Administrative Sciences (1987); PhD, Purdue University, 1971.

Dan Trietsch, Associate Professor of Operations Management and Logistics (1987); PhD, Tel Aviv University, 1983

Linda E. Wargo, Adjunct Professor of Total Quality Leadership (1991); MS, Naval Postgraduate School, 1983.

Jeffery A. Warmington, LCDR, U.S. Navy, Instructor in Acquisition & Contracting (1992); MS, Naval Postgraduate School, 1988.

Ronald Alfred Weitzman, Associate Professor of Psychology (1971); PhD, Princeton University, 1959.

David Richard Whipple, Jr., Professor of Economics and Policy Analysis (1971); PhD, University of Kansas, 1971.

Leslie John Zambo, Adjunct Professor of Financial Management (1986); PhD, University of Texas, 1981.

Stephen Zirschky, Adjunct Professor of Acquisition & Contracting (1991); L.L.M., McGeorge School of Law, 1989.

Moshe E. Zviran, Assistant Professor of Management Information Systems (1988); PhD, Tel Aviv University, 1988.

Dani Zweig, Assistant Professor of Information Systems (1990); PhD, Carnegie Mellon University, 1989.

*The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Administrative Sciences has primary responsibility for three academic programs and awards four graduate degrees. The largest program is a group of curricula in Administrative Sciences. These curricula include Acquisition and Contract Management, Financial Management, Manpower/Personnel/Training Analysis, Material Logistics Support, Systems Inventory Management and Transportation Management. Graduates of these curricula are awarded the degree Master of Science in Management. The Administrative Sciences curricula are accredited by the National Association of Schools of Public Affairs and Administration.

Next largest is the Computer Systems Management Curriculum, whose graduates receive the Master of Science in Information Systems. Finally, the Telecommunications Systems Management Curriculum leads to the degree Master of Science in Telecommunications Systems Management.

The Department has three micro-computer laboratories for instructional and research purposes.

MASTER OF SCIENCE IN INFORMATION SYSTEMS
A candidate for the degree of Master of Science in Information Systems must successfully complete or validate core courses in each of the following disciplines:

Accounting and Financial Management
Organization Sciences
Information Systems
Computer Science
Economics
Management Theory and Practice Quantitative Methods

In addition, each candidate's curriculum must include the successful completion of 48-quarter hours of graduate-level course work and an acceptable thesis or project. At least 12-quarter hours of the course work must be at the 4000 level. Further, this graduate-level course work must include at least 24-quarter hours in Administrative Sciences and at least 16-quarter hours in Computer Science.

The candidate's program must be approved by the Chairman of the Department of Administrative Sciences.

MASTER OF SCIENCE IN MANAGEMENT

The degree Master of Science in Management requires:

1) Completion or validation of the Management Fundamentals program, which consists of a total of 32-quarter hours of 2000 and 3000 level courses, including a minimum of the following hours by disciplines:

Accounting and Financial Management	6
Economics	6
Organization and Management	6
Quantitative Methods	8

2) In addition to the above, completion of a minimum of 48 hours of graduate-level courses, at least 12 hours of which are at the 4000 level.

3) The completion of an approved sequence of courses in the student's area of concentration.

4) The submission of an acceptable thesis on a topic previously approved by the Department of Administrative Sciences.

5) Final approval of a program from the Chairman, Department of Administrative Sciences.

MASTER OF SCIENCE IN TELECOMMUNICATIONS SYSTEMS MANAGEMENT

The degree Master of Science in Telecommunications Systems Management will be awarded at the completion of an inter-disciplinary program that satisfies the following requirements:

1) A minimum of 56-quarter hours of graduate-level work, of which at least 12-quarter hours must represent courses at the 4000 level.

2) The program must consist of a minimum of graduate-level credit as follows:

Administrative Sciences and Quantitative Methods	40
Communication Systems and Computer Science	16

3) In addition to the 56-quarter hours of graduate-level course credit, an acceptable thesis must be completed. Each thesis shall have an advisor and a second reader, at least one of whom must be from the Department of Administrative Sciences.

4) The program must be approved by the Chairman, Department of Administrative Sciences.

DOCTOR OF PHILOSOPHY IN ADMINISTRATIVE SCIENCE

The Department of Administrative Sciences has a program leading to the degree Doctor of Philosophy. Areas of specialization for doctoral studies are organization and management, and information technology. Minors in areas of other departments are possible. A noteworthy feature of these areas of research is that the candidate's research may be conducted off-campus in the candidate's sponsoring laboratory or unit of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree. For more information, please contact Chairman, Administrative Sciences.

COURSE OFFERINGS

AS3610 ECONOMIC ANALYSIS AND OPERATIONS RESEARCH (4-0).
A presentation of basic economic concepts involved in the decision processes of individuals and groups faced with scarcity of resources. Topics covered include consumer theory and demand, individual behavior under uncertainty, output and input market structures, partial and general equilibrium analysis and market imperfections and welfare systems aanalysis. PREREQUISITES: MA2042, MA2110(concurrently) and OA3201 (concurrently).

AS3611 PLANNING AND CAPITAL ALLOCATION IN THE DEPARTMENT OF DEFENSE (4-1).
Extension of concepts discussed in AS3610 to allocation of resources over time. Covered are models of consumption and production over time, optimal investment decision rules and investment under uncertainty. Models of welfare economics and cost-benefit analysis are presented. Cost effectiveness and costing models from current practices in DoD are examined. Institutional procedures and processes such as PPBS, SYDP and weapons acquisition are also discussed. PREREQUISITES: AS3610 and OA3103.

AS4613 THEORY OF SYSTEMS ANALYSIS (4-0).
Systems analysis (cost-effectiveness analysis) formulated as commensurable and incommensurable physical capital investment choice models. Emphasis on decision rules and the nature of opportunity costs with respect to scale and timing of investment. Interpretation of methods of risk, modeling and solution computation. Theory of the second best: theory of the social discount rate. Introduction to models planning and control emphasizing decentralization of the decision making problem. PREREQUISITES: AS3611 and OA4201 (concurrently).

CM3112 NAVY TELECOMMUNICATIONS SYSTEMS (4-0).
Description of the Naval Telecommunications Systems, with emphasis on the organization and management control and operational direction of the facilities. Current subsystems are described in detail. PREREQUISITES: SECRET clearance and CM3111 or permission of the Instructor.

IS0001 SEMINAR FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (NO CREDIT) (0-2).
Guest lectures. Thesis and research presentations.

IS0123 COMPUTER SKILLS DEVELOPMENT (NO CREDIT) (0-2).
An introduction to the use and operation of microcomputers with emphasis on applications in the administrative sciences. Exposure to pertinent software packages. Graded on a Pass/Fail basis only.

IS0810 THESIS RESEARCH FOR INFORMATION TECHNOLOGY MANAGEMENT STUDENTS (0-0).
Every student conducting thesis research will enroll in this course.

IS1004 INTRODUCTION TO PC DATA BASE SYSTEMS (0-1).
This course provides an introduction to PC-based database management systems (DBMS) such as Ashton-Tate's current version of the dBase product, or PC-based Ingres. The student will develop simple applications in the DBMS using the query processor and associated application generators provided by the software. PREREQUISITE: Introduction to DOS, or a basic familiarity with the DOS operating system for PCs.

IS2000 INTRODUCTION TO COMPUTER MANAGEMENT (3-1).
This course will provide an introduction to the field of automatic data processing and the functions and responsibilities of the computer manager. Specific topics include a survey of contemporary computer applications, hardware and software, and introductions to personnel management, financial management, quantitative methods and computer science in the computer management function.

IS3000 DISTRIBUTED COMPUTER SYSTEM (4-0).
This course covers the technology, application and management of distributed computer systems. Specific topics include distributed processing, distributed database management, communication facilities and protocols, economic and performance analysis and managerial and organizational problems. PREREQUISITES: CS2970, CS3010 and IS3170 (may be taken concurrently.)

IS3020 SOFTWARE DESIGN (3-2).
The course is concerned with the use of structured techniques in the design and implementation of software. Topics covered include selection of programming languages, design of modules and module interfaces, testing and program documentation techniques. The course also covers the use of software metrics for determining program size, complexity and quality.

IS3100 ANALYSIS OF MICROCOMPUTERS AND MICROPROCESSORS (4-0).
A comparative analysis of popular microcomputers-hardware and software. Analyses will be made of the following elements: microcomputer architecture (IBM AT and PS/2, Macintosh, Sun workstation); microprocessors (Intel 8026, 386 and 486 and Motorola 68000; bus systems (ISA, EISA, MCA Nubus); operating systems (DOS, OS/2, Unix); applications (document preparation, network server, workstation). Comparisons will be made both within a vendor's product line and between vendors, with respect to characteristics, strengths, limitations, applications and costs. Tours of Silicon Valley microcomputer and semi-conductor plants. Student written and oral reports on comparative analyses. Some assembly language programming will be required. PREREQUISITES: CS3010 and CS3030.

IS3170 ECONOMIC EVALUATION OF INFORMATION SYSTEMS I (4-0).
The basic principles of microeconomics applied to information systems. Microeconomic topics include demand, cost, production theory, competition, monopoly, interest rates and present values. Information systems topics include capacity planning, capital budgeting, pricing for computer services and a study of the information industries (computers and software). PREREQUISITE: MN2155 (may be taken concurrently).

IS3171 ECONOMIC EVALUATION OF INFORMATION SYSTEMS II (4-0).
(new course, description not available at time of printing)

IS3183 MANAGEMENT INFORMATION SYSTEMS (4-0).
Study of what an information system is, how the computer and other resources fit into the system, and management considerations involved in computer-based information systems. Issues will be discussed from the perspective of the user of information systems and not that of the MIS specialist. PREREQUISITES: MN3105 and IS0123.

IS3502 COMPUTER NETWORKS: WIDE AREA/LOCAL AREA (4-0).
Analysis, evaluation, management and development of wide area and local area computer networks and supporting packet switching computer communication systems. Specific topics include network architectures, protocols, functions, standards, error detection/correction, cost reduction, interconnection, management and security. Example systems include Defense Data Network, System Network Architecture, DECNET, Ethernet, token ring, broad band, fiber optics, private automatic branch exchanges and satellite communications systems. PREREQUISITES: CS2970, CS3010 and OS3004.

IS3503 MICROCOMPUTER NETWORKS (3-2).
This course covers the theory, application and operation of micro-computer networks. Students learn, evaluate, compare and operate several contemporary microcomputer networks, such as IBM PC Net, IBM Token-Ring, Apple Computer Apple-Talk, 3 Comm Ethernet, mainframe emulations and LAN internets. Student reports on comparative evaluations of contemporary microcomputer networks will be required. The IEEE Local Area Network Standards will be covered. PREREQUISITE: IS3502 concurrently.

IS4182 INFORMATION SYSTEMS MANAGEMENT (4-0).
Management of ADP in the Federal government, especially in the Department of Defense. Specific topics include identification of problems managing information systems, the identification of appropriate analytical methods to reduce risk, minimize negative impacts or to solve those problems. It is the capstone CSM course that draws from previous courses and studies the development of practical, workable solutions to information resource management (IRM) problems. PREREQUISITE: IS4200 (concurrently).

IS4183 APPLICATIONS OF DATABASE MANAGEMENT SYSTEMS (4-1).
Applications-oriented introduction to database management systems technology. Survey of current database systems and approaches to database technology. Technical and administrative considerations involved in a database implementation project are considered. Students will be expected to implement an applications systems using a data base management package. PREREQUISITES: CS3010, CS3020 and IS2000.

IS4184 INFORMATION RESOURCE MANAGEMENT IN DON/DOD (4-0).
This course is concerned with understanding the major aspects of IRM and how it is conducted in DoD and DoN. Special attention will be paid to data base administration and information engineering. Examples of IRM and DBA practice will be presented via case studies and by speakers with relevant expertise from the Navy, DoD and private sector.

IS4185 DECISION SUPPORT SYSTEMS (4-1).
The application and design of computer-based information systems to support decision making for management planning, control and operations. Survey of current decision support systems and approaches to DSS technology, including artificial intelligence and expert systems. Students will be expected to implement an application system using available DSS tools. PREREQUISITES: MN2155, MN3105, OS3101 and IS2000 or equivalent.

IS4186 INTRODUCTION TO KNOWLEDGE-BASED SYSTEMS AND ARTIFICIAL INTELLIGENCE (4-1).
This course has two main objectives: 1) to introduce the principles and applications of knowledge-based systems including expert systems, and 2) to introduce certain fundamental techniques, commonly employed in designing such systems, from the field of artificial intelligence. The potential and limitations of expert systems will be discussed so as to make students aware of the usefulness of expert systems as problem-solving and decision support tools. Hands-on experimentation and implementation of prototype systems will be emphasized. Topics to be covered include knowledge-representation techniques, rule-based systems, inference and search techniques, example-based learning and analogical reasoning, and expert systems architectures. The course will also cover some of several special topics: belief revisions and reasoning under uncertainty, meta-interpreters, logic programming, and applications of expert systems in particular domains such as manufacturing, legal reasoning, medical diagnosis, and military applications such as avionics systems. PREREQUISITES: IS2000, OS3101, MA1248 or equivalent.

IS4200 SYSTEM ANALYSIS AND DESIGN (4-0).
This course covers computer-based system development, including the following concepts, methodologies, tools and techniques for: information systems requirements analysis, technical and economic feasibility studies, systems costing and data communications hardware and software trade-off evaluations and specifications, conversion and testing. PREREQUISITES: CS2810, CS3010 and IS3020 or CS2810, CS3111 and CS3400.

IS4300 SOFTWARE ENGINEERING AND MANAGEMENT (4-0).
The objective of this course is to educate the student in areas of great concern to the Department of Defense in the fields of software engineering and management. The course examines both the technological tools of software production as well as the software engineering techniques for software project management. Software testing, metrics and reliability are also covered. PREREQUISITES: CS3030, IS3170 and OS3004.

IS4320 DATABASE AND INFORMATION RESOURCE MANAGEMENT FOR C3 (4-0).
Applications-oriented introduction to database management systems technology with emphasis on C3 applications. Survey of current database systems and developments in database technology. Introduction to the concepts of information resource management and how information policy is implemented in the Navy. Specific topics include the relational data model, use of the SQL data manipulation language, aspects of database administration and the role of database technology in information resource management. Students will be expected to implement a prototype application using a commercial relational database management system. PREREQUISITE: IS3020 Software Design, or equivalent.

IS4502 TELECOMMUNICATIONS NETWORK (4-0).
This course is primarily concerned with understanding technological trends in telecommunications networks. Topics to be covered include public packet-switched services T1/T3 networks, satellite transmissions ISDN and OSI interoperability issues. Such technological reviews are followed by a discussion on techniques for network planning and administration. Examples of computerized network management tools are examined. Network security issues are also discussed.

IS4800 DIRECTED STUDY IN ADVANCED INFORMATION SYSTEMS (Variable hours) (V-0).
Directed study in advanced topics in information systems of mutual interest to student and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. Graded on a Pass/Fail basis only.

IS4925 SEMINAR IN INFORMATION SYSTEMS (Variable hours 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in information systems, to be determined by the instructor. PREREQUISITES: A background of information systems and permission of the instructor.

MN0001 SEMINAR FOR ADMINISTRATIVE SCIENCE STUDENTS (NO CREDIT) (0-2).
Guests lectures. Thesis and research presentations.

MN0810 THESIS RESEARCH FOR ADMINISTRATIVE SCIENCE STUDENTS (0-0).
Every student conducting thesis research will enroll in this course.

MN2031 ECONOMIC DECISION MAKING (4-0).
The macroeconomic section focuses on methods of national income determination, the consumption function, the multiplier and the impact of fiscal and monetary policies. The microeconomic section analyzes individual economic decisions and their relation to attainment of market equilibria. PREREQUISITE: MA2300 (concurrently).

MN2111 SEMINAR IN MANPOWER, PERSONNEL AND TRAINING ISSUES I (0-2).
An introduction to the major issues, theory and practice of the military MPT system. Graded on a Pass/Fail basis only.

MN2112 SEMINAR IN MANPOWER, PERSONNEL AND TRAINING ISSUES II (0-2).
Exposure to elementary analysis of problems and issues in the contemporary military MPT system. Graded on Pass/Fail basis only.

MN2113 SEMINAR IN MANPOWER, PERSONNEL AND TRAINING ISSUES III (0-2).
An introduction to the training issues and technologies and their application in the military setting. Graded on a Pass/Fail basis only.

MN2150 FINANCIAL ACCOUNTING (4-0).
Study of basic accounting concepts and standards. Specific topics include the accounting cycle, asset valuation, liabilities and capital structure, earnings measurement, cash flow analysis and financial statement analysis.

MN2155 ACCOUNTING FOR MANAGEMENT (4-0).
Brief introduction to financial accounting, with emphasis on the content and analysis of financial statements. Specific topics in management accounting include fundamentals of cost accounting, cost-volume-profit analysis, budgeting, relevant costs for decision making, capital budgeting and financial performance measures. (Closed to students in Administrative Science curricula.)

MN2302 SEMINAR FOR ACQUISITION AND CONTRACTING STUDENTS (0-2).
This course brings both Government and industry contract managers into the academic forum for interaction with students. Visits to Government facilities and commercial plants. Thesis and research presentations. Preparation for Certified Professional Contracts Manager Certificate examinations. Graded on a Pass/Fail basis only.

MN2303 SEMINAR FOR PROGRAM MANAGEMENT STUDENTS (0-2).
This course brings both Government and industry acquisition/program managers into the academic forum for interaction with students. Guest lecturers include program executive officers, program managers, laboratory and field personnel, OSD officials, congressional members and staff personnel and industry representatives. Visits to Government facilities and commercial plants. Thesis and research presentations. Graded on a Pass/Fail basis only.

MN3105 ORGANIZATION AND MANAGEMENT (4-0).
Study of the elements of management in organizations facing a dynamic environment. Emphasis is on contemporary management principles and theories of decision-making, leadership, planning and control, organizational structure and planned organizational change, and their systemic impacts on organizational effectiveness and adaptation. Extensive use is made of DOD cases involving the management of civilian and military personnel.

MN3111 PERSONNEL MANAGEMENT PROCESSES (4-0).
A broad coverage of human behavior in the work situation, with special emphasis on the problem of work in the Naval environment. Topical areas covered include selection, placement, training and evaluation of personnel; motivation, remuneration, morale, supervision and working conditions in organizations; equipment design and man-machine relationships; and, consumer (user) behavior and the impact of technological programs. PREREQUISITES: MN3105 and OS3106 (concurrently) or equivalent.

MN3123 MILITARY SOCIOLOGY (4-0).
An exploration of classical theories of sociology pertaining to civilian-military relations with modern applications to command and control problems. Sexism, racism, family dissolution, unionization, bureaucratic inertia, career patterns, professionalism and other topics are considered from the perspective of sociology. PREREQUISITE: MN3105.

MN3140 MICROECONOMIC THEORY (4-0).
Determination of the allocation of resources and the distribution of output. Consumer and producer choice theory. Partial equilibrium analysis. Welfare economics. Applications to defense problems are emphasized. PREREQUISITES: MA2300 and MN2031.

MN3154 FINANCIAL MANAGEMENT IN THE ARMED FORCES (4-0).
Review of financial management concepts and practices in DOD and the Armed Forces, with emphasis on the Department of the Navy. Includes study of PPBS, controllership, budget formulation and execution, headquarters and field activity accounting systems and various types of funds. PREREQUISITE: MN2155 or MN3161.

MN3161 MANAGEMENT ACCOUNTING (4-0).
Introduction to cost determination systems, including job order systems, overhead costing, standard costs and unit costing. Emphasis is on applications of financial data to planning, control and decision making in governmental organizations. Topics covered include budgeting, flexible budgets, variance analysis, performance measures, cost-volume-profit analysis, cost analysis for decision-making and capital budgeting. PREREQUISITE: MN2150.

MN3172 PUBLIC POLICY AND BUDGETING (4-0).
This course analyzes federal fiscal policy with emphasis on resource decision making for national defense. The roles of principal budget process participants are defined. Executive and congressional budget processes are examined to indicate how the political, social and economic objectives of government are implemented through fiscal policy. Budget formulation, negotiation, and execution strategies are evaluated to indicate the dynamics of Executive-Legislative competition over resource allocation priorities.

MN3301 SYSTEMS ACQUISITION AND PROJECT MANAGEMENT (4-0).
This course provides the student with an understanding of the underlying philosophies and concepts of the systems acquisition process and the practical application of project management methods within this process. Topics include the evolution and current state of systems acquisition management; the defense systems acquisition cycle; user-producer acquisition management disciplines and activities; and project planning, organization, staffing, directing and controlling.

MN3303 PRINCIPLES OF ACQUISITION AND CONTRACTING (4-0).
Introduction to the principles of acquisition and contracting. This course presents the fundamentals of the Federal Acquisition Regulation and the DoD Supplement; the acquisition and contracting processes, including requirements determination, acquisition strategies, basic contract law, ethics, contract types, contracting methods and acquisition/ contract management techniques.

MN3304 CONTRACT PRICING AND NEGOTIATIONS (5-2).
This course involves the study of pricing theory and strategies, cost methods, cost and price analysis, cost principles, Cost Accounting Standards and contract negotiations. Students develop and sharpen negotiating skills by participating in practical negotiation exercises. PREREQUISITES: MN3140 and MN3303.

MN3305 CONTRACT ADMINISTRATION (3-0).
This course stresses the management skills and techniques necessary for the successful administration of Government prime contracts and subcontracts. Topics include managing contract progress and performance, change control, quality control, cost/financial control, property, terminations and regulatory and policy concerns. PREREQUISITE: MN3304.

MN3307 ADP ACQUISITION (4-0).
Introduction to the management principles, concepts and issues involved in Federal Government acquisition of ADP requirements and Federal Information Processing (FIP) Resources.. The course focuses on the concepts of systems acquisition and project management, as they pertain to ADP/FIP acquisition and specific purchases of computer hardware and software. PREREQUISITE: Enrollment in Computer Systems Management curriculum or permission of the instructor.

MN3312 CONTRACT LAW (3-0).
Examines the legal structure within which Federal Government contracts with private industry are formulated and used. Includes such topics as agency authority, contract interpretation, disputes and remedies, socio-economic laws, labor law, property, patents and data rights, conflicts of interest, protests and ethics. PREREQUISITE: MN3303.

MN3333 MANAGERIAL COMMUNICATION SKILLS (4-0).
This course provides students with the writing, speaking, listening, team management and critical thinking skills required of them to be effective officers. Instruction concentrates on

media selection strategies, writing informative and persuasive documents, giving effective presentations, managing team processes and developing the communication competencies of subordinates through effective feedback. The course focuses on communication issues unique to the Navy and DoD.

MN3334 MANAGERIAL COMMUNICATIONS LAB FOR INTERNATIONAL STUDENTS (0-1).
This lab complements MN3333 and is specifically designed to provide practice in oral and written communications for Allied Officers. It is particularly useful in helping students identify culturally specific differences in organization and style for oral and written communications. Furthermore, students receive highly individualized instruction to help them complete managerial communications assignments.

MN3371 CONTRACTS MANAGEMENT AND ADMINISTRATION (4-0).
Introduces the procurement and contracting system to non-procurement personnel. Study of the characteristics and phases of the contracting process. Coverage includes planning, execution and control of the contracting process; techniques used in purchasing goods and services of varying complexities; and the relationship of contracting to the acquisition process.

MN3372 MATERIAL LOGISTICS (4-0).
An overview of material logistics emphasizing DoD material support systems in CONUS. Topics include forecasting, inventory management, warehousing, transportation, facilities location, materials handling and logistics planning and control processes. A basic course for students in the 819 and 827 curricula. PREREQUISITES: Management Calculus (MA2300 or equivalent) and OS3101.

MN3373 DOMESTIC TRANSPORTATION MANAGEMENT (4-0).
Analysis of domestic U.S. transportation systems from a managerial perspective. Topics include carriers and users of systems; alternative modes; intra and intermodal competitive relationships; regulatory and legal considerations; demand, cost and pricing analysis; and managerial resource problems. Application of these topics to the DoD domestic freight transportation allocation problems is emphasized. A basic course for the 813 and 814 curricula. PREREQUISITE: MN3140 (may be taken concurrently).

MN3374 PRODUCTION MANAGEMENT: A TQM/L PERSPECTIVE (4-0).
Qualitative issues and quantitative techniques for contemporary production/operations management (POM). Qualitative issues covered include the fundamentals of total quality management/leadership, strategic considerations for quality (e.g., automation versus streamlined flow of materials) and synchronized operations (e.g., JIT techniques). Quantitative techniques include monitoring quality, forecasting, queueing, facilities planning, aggregate planning and scheduling. Examples are included which illustrate application to DoD production and service activities. A required course for the 827 curricula. PREREQUISITE: OS3006.

MN3375 MATERIALS HANDLING SYSTEMS DESIGN (4-0).
A study of the principles and system concepts of materials handling and their application in the design of a materials handling system. Such systems are an essential part of an efficient military logistics organization. The Navy's NISTARS system is examined in detail. A variety of current DOD materials handling problems are dicussed. A required course for the 813 and 814 curricula.

MN3377 INVENTORY MANAGEMENT (4-0).
This course examines the organizations, functions, processes and resources that must be integrated to effectively manage DoN and DoD inventories. We will study parts of requirements determination, configuration tracking, distribution, warehousing, procurement, transportation, requisitioning and financial management systems as they apply to military inventories. A required course for the 819, 827 (Supply Crops students), and 817 USMC curricula. The course is also a key part of the professional educational development of all Navy Supply Corps Officers who attend the School. PREREQUISITES: Management Calculus (MA2300 or equivalent) and OS3101.

MN3760 MANPOWER ECONOMICS I (4-0).
An introduction to the theoretical aspects of labor economics. Concepts covered include the supply of labor, the demand for labor, market wage determination, internal labor markets, human capital formation and earnings functions, migration and turnover, compensating wage differentials and pay and employment discrimination. Military applications of the principles are developed. PREREQUISITE: MN3140.

MN3801 TECHNOLOGY TRANSFER (4-0).
The study of dissemination and utilization of technology and associated problems, with emphasis on communications, sociology and organizational factors. PREREQUISITE: MN3105 or graduate standing in a technical curriculum and permission of the instructor.

MN3900 READINGS IN ADMINISTRATIVE SCIENCE (4-0).
An individualized program of readings and study in some area of the administrative sciences, designed to meet the student's special educational needs. PREREQUISITES: A background in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN3902 MPT COMPUTER SKILLS ENHANCEMENT (0-2).
An introduction to data analysis using a computer. Topics include methods of file creation, storage and transfer. Elementary programming concepts are introduced using a statistical software package.

MN4105 MANAGEMENT POLICY (4-0).
Study and analysis of complex managerial situations requiring comprehensive integrated decision making. Topics include operational and strategic planning, policy formulation, executive control, environmental adaptation and management of change. Case studies in both the public and private sectors are used. Particular attention is given to strategic management in the military context, and in the challenging DoD, DoN organizations. PREREQUISITE: Open only to students in the final quarter of an Administrative Science curriculum, Computer Systems Management, or Telecommunications Systems Management.

MN4106 MANPOWER/PERSONNEL POLICY ANALYSIS (4-0).
Study and analysis of military manpower/personnel policy alternatives with emphasis on identifying the trade-offs involved, the dynamic impact of major policy decisions and the short-term and long-term consequences of decisions. Review, use and evaluation of tools to aid in selecting policy alternatives. Study of representative cases in the DoD and military services. PREREQUISITE: Open only to students in the final quarter of the Manpower, Personnel and Training Analysis curriculum.

MN4110 MULTIVARIATE MANPOWER DATA ANALYSIS I (5-1).
An introduction to multivariate data analysis using regression models. Topics include data requirements, hypothesis testing, generalizations of the linear model under different covariance structures, multicolinearity, dummy variables, forecasting and estimation of binary choice models. Applications of techniques to military manpower data are stressed. PREREQUISITE: A course in statistics.

MN4111 MULTIVARIATE MANPOWER DATA ANALYSIS II (5-1).
An introduction to the specialized multivariate techniques used for analysis of military manpower data. Topics include an introduction to study design and sampling theory, maximum likelihood estimation, techniques for analyzing limited dependent and qualitative data, methods for analyzing the dependence structure of a multivariate sample analysis of duration data and an introduction to simultaneous equations models. PREREQUISITE: A course in statistics.

MN4112 PERSONNEL TESTING AND SELECTION (4-0).
Study of methods available for evaluating and predicting training and work performance in organizations like the Navy: employment interviewing, testing, life-history data and rating scales, with some reference to job analysis and recruitment. Special emphasis on

testing concepts and models particularly in relation to the computerization of the Armed Services Vocational Aptitude Battery, equal employment opportunity and selection decisions based on cost benefit analysis. PREREQUISITE: MN4110 or equivalent with approval of instructor.

MN4115 TRAINING FOUNDATIONS AND MANAGEMENT (4-0).
Examination of issues in DoD training and education. Major topics include foundations of learning, training technologies and systems, design and implementation of training and program evaluation. Emphasis is placed on the application of training processes in the military environment. Course will be available as curriculum option for students in 847 (MPTA) Curriculum.

MN4117 JOB ANALYSIS AND PERSONNEL TRAINING (4-0).
Study of job analysis and its use in determining training requirements. Consideration of instructional systems development and training pipeline management. Attention to cost-benefit issues involving training in regard to selection, equipment design, changing job requirements and career development. PREREQUISITE: MN3111.

MN4119 SEMINAR IN MANPOWER ANALYSIS (Variable credit 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in manpower analysis, to be determined by the instructor. PREREQUISITES: A background in manpower analysis and permission of the instructor.

MN4121 ORGANIZATION THEORY (4-0).
Study of the major theories of modern organizations. This course emphasizes the analysis of organizational phenomena from multiple perspectives, using theories of individual, group and organizational behavior. Topics include organization design and culture, political analysis of organizations, management of change, open systems theory and contingency theories. PREREQUISITE: MN3105.

MN4122 PLANNING AND CONTROL: MEASUREMENT AND EVALUATION (4-0).
Theory and techniques of the managerial functions of planning and control. Emphasis is placed on the effects of the planning and control structure on the behavior of human components of the system. Topics include the problems associated with the utilization of surrogates for measurement purposes; the analysis of the influence of assumptions, values and objectives on the planning and control process; budgeting and forecasting and performance evaluation and the reward structure. PREREQUISITE: MN4161.

MN4125 MANAGING PLANNED CHANGE IN COMPLEX ORGANIZATIONS (4-0).
Examination of the approaches to planning and managing change efforts in complex social systems made up of the interdependent components of technology, structure, task and people and of the role of the manager or staff specialist and the process of helping. Emphasis is placed on strategies and technologies for diagnosis and planning aimed at effective implementation. Opportunities for practice using both simulations and actual organizational cases. Particular emphasis is placed on the DoD, DoN organizations and the special problems they have in bringing about change. PREREQUISITE: MN3105.

MN4127 SEMINAR IN ORGANIZATION BEHAVIOR (Variable credit 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in organization behavior, to be determined by the instructor. PREREQUISITES: A background in organization behavior and permission of the instructor.

MN4145 POLICY ANALYSIS (4-0).
The application of economic methods to non-market transactions. Analysis of large scale defense resource allocation problems. Weapon system definition. Life cycle cost models. Examples of cost-benefit and cost-effectiveness analyses. PREREQUISITES: MN3140, MN3161 and OS3106 or equivalent.

MN4151 INTERNAL CONTROL AND AUDITING (4-0).
Study of the objectives and techniques of internal control systems and of audits of financial reports and records. Specific topics include the internal control structure and evaluation of internal control, audit reports, government auditing standards, audit evidence and audit tests, the auditor's decision process, statistical sampling, and special controls and audit problems in computer-based systems. Audits of several transaction cycles are examined. PREREQUISITES: MN3161 and OS3101.

MN4152 CORPORATE FINANCIAL MANAGEMENT (4-0).
The management of the finance function in industry, with particular attention to defense contractors. Specific topics include cash and working capital management, long-term financing and determination of optimal capital structure. PREREQUISITE: MN3161.

MN4153 SEMINAR IN FINANCIAL MANAGEMENT (Variable hours 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in financial management, to be determined by the instructor. PREREQUISITES: A background in financial management and permission of the instructor.

MN4159 FINANCIAL REPORTING AND ANALYSIS (4-0).
Advanced study of basic accounting concepts underlying published financial reports. Emphasis is placed on the measurement, communication and evaluation processes. Topics include setting accounting policies, alternative bases of valuation, alternative concepts of earnings and discussion of controversial accounting issues. The course takes the perspective of managers and users of financial information. PREREQUISITE: MN3161.

MN4161 MANAGEMENT CONTROL SYSTEMS (4-0).
Study of the structure and the processes of management control in government organizations. Specific topics include the basic concepts of planning and control, organization of the management control function, measurement of inputs and outputs, pricing government services, programming, budgeting, accounting and performance evaluation. PREREQUISITES: MN3105 and MN3161.

MN4162 COST ACCOUNTING (4-0).
Review of basic cost accounting procedures. In-depth study of cost accounting systems, allocation of direct and indirect costs to cost objectives, activity-based costing and special problems of accounting for materials, labor and overhead costs. Specific attention is given to the objectives and the substance of Cost Accounting Standards for negotiated defense procurement contracts. PREREQUISITE: MN3161.

MN4163 ANALYTICAL TECHNIQUES FOR FINANCIAL CONTROL AND PLANNING (4-0).
Study of quantitative methods most useful for financial planning and control. Emphasis is on developing quantitative methods as decision support tools, with available computer software as computational aids. Covered are introductions to the relevant quantitative techniques, the conditions for successful applications, data needed for applications and the use of computational aids for problem solving. The goal is to provide sufficient competency for students to apply sophisticated analytical techniques to various planning and control environments in the public sector. PREREQUISITES: MN3161 and OS3101.

MN4301 CONTRACTING FOR MAJOR SYSTEMS (4-0).
Study of the major systems contracting process, procedures and practices. This course focuses on the contracting process of the Naval Systems Commands and the Major Defense Acquisition Process. Major topics include contracting organization for systems acquisition, systems acquisition process, business clearance process, source selection, multi-year procurement, pricing and administration of major systems contracts. Related topics include funding, reliability/maintainability, ILS, research and development, test and evaluation, and congressional activity. PREREQUISITE: MN3305 or permission of the instructor.

MN4302 DEFENSE RESOURCE POLICY MANAGEMENT (4-0).
National defense policy formulation and execution and its impact on the defense budget. Analysis of contemporary defense policy and management issues and their resource implications. Relationships between DoD, the military departments, the defense industry and Congress in the policy and resource decision-making process. PREREQUISITE: MN3172.

MN4307 PROGRAM MANAGEMENT POLICY AND CONTROL (4-0).
Provides the student with knowledge of management control processes and tools, design and application of control systems, use of computer-based management information systems with emphasis on real world, practical systems for performance, cost and schedule control. Case studies involving managerial problem solving and decision making in the program management environment are used. PREREQUISITES: MN3301, MN3371 and permission of the instructor.

MN4310 LOGISTICS ENGINEERING (4-0).
The concept of integrated logistics support and its relationships with systems engineering in the design of military weapon systems. Operational requirements, system maintenance concept, functional analysis, life cycle costs, logistics support analysis, systems design, test and evaluation, production, provisioning and resupply of spare and repair parts are discussed. A required course for the 819, 827 and 361 curricula satisfying the Educational Skill Requirements to understand all aspects of integrated logistics support. PREREQUISITE: OS3006 (concurrently).

MN4371 ACQUISITION AND CONTRACTING POLICY (4-0).
A seminar using case studies and current acquisition issues to analyze Government and business acquisition/contracting policies. Emphasis is on acquisition/contracting decision making and policy formulation execution. PREREQUISITE: MN4301.

MN4372 SEMINAR IN ACQUISITION AND CONTRACT MANAGEMENT (Variable hours 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in acquisition and contracting, to be determined by the instructor. PREREQUISITES: A background in acquisition and permission of the instructor.

MN4373 INTERNATIONAL TRANSPORTATION MANAGEMENT (4-0).
Analysis of international transportation systems from a managerial perspective. Topics include carriers and users of systems, alternative modes, intra- and intermodal competitive relationships, regulatory and legal considerations, demand, cost and pricing analysis, and managerial resource problems. Application of these topics to DoD international freight transporation allocation problems is emphasized. A basic course for the 813 and 814 curricula. PREREQUISITE: MN3373.

MN4376 DEFENSE TRANSPORTATION SYSTEM (4-0).
Analysis of the organizational structure and environment of the Defense Transportation System, strategic planning systems for conventional warfare and their requirements for the Defense Transportation System, strategic sealift and tradeoffs surrounding its roles and capabilities, issues and analysis concerning the Defense Transportation System and other large-scale transportation networks. A required course for the 813, 814 and 361 curricula. PREREQUISITE: MN4373 or consent of instructor.

MN4377 TQM/TQL: PHILOSOPHY, THEORY, TOOLS (4-0).
Deming's 14 points (philosophy and basic theory). The 7 basic graphic tools (flow charts, cause-and-effect diagrams, Pareto charts, histograms, scatter diagrams, run charts and control charts), which help analyze genric processes. Advanced theories and techniques designed to address quality issues of specific types, including SMED (single minute exchange of die, or setup reduction), Poka-Yoke (mistake proofing), Synchronized Operations (also known as Just-In-Time), Statistical Experimental Methods for off-line quality improvement such as Taguchi Methods, Total Preventive maintenance, and Group Technology. We'll discuss how these methods, developed predominantly in the

manufacturing environment, can be used in services. PREREQUISITE: Any 3000 level course in probability and statistics.

MN4500 PRODUCTIVITY ANALYSIS (4-0).
Study of the theoretical and institutional foundations of the analysis of productivity measurement and enhancement programs in DoD. Emphasis is placed on methods of applying microeconomic and organizational effectiveness principles and concepts to the critical analysis of proposed and existing DoD productivity programs, as well as to the development of alternatives which have higher probabilities of effecting the desired increases in program effectiveness and efficiency. PREREQUISITES: MN3105 and MN3140.

MN4650 THE MILITARY HEALTH CARE DELIVERY SYSTEM AND ANALYSIS (4-0).
This course is designed to acquaint the student with the structure and operation of the Department of Defense's system for providing health care to those eligible under current regulations; to identity current problem areas; and, through application of systems analys and management techniques, to address the possible solutions to these problems in a course project. PREREQUISITE: MN3650.

MN4761 APPLIED MANPOWER ANALYSIS (4-0).
Application of theoretical models and quantitative techniques to military manpower, personnel and training issues. Topics include manpower supply models, attrition and reenlistment models, manpower requirements determination, force structure analysis, manpower productivity and compensation systems.

MN4900 READINGS IN ADMINISTRATIVE SCIENCE (Variable hours 1-0 to 4-0) (V-0).
An individualized program of advanced readings and study in some area of administrative science. PREREQUISITES: A background of advanced work in the area of study and departmental approval. Graded on a Pass/Fail basis only.

MN4904 MPT RESEARCH APPLICATIONS (0-2).
Applications of research techniques to manpower problems. PREREQUISITE: MN4106.

MN4942 THE STRUCTURE, CONDUCT AND PERFORMANCE OF THE DEFENSE INDUSTRIES (4-0).
A study of selected defense industries' structures (e.g., seller concentration, product differentiation, barriers to entry, demand for products and buyer concentration), conduct (e.g., pricing policy, product characteristics policy and policies toward rivals and customer and performance (e.g., efficiency, progress and employment). The government as consume and regulator. Typical industries studied are aerospace, computers, shipbuilding and telecommunications. PREREQUISITE: MN3140 or equivalent.

MN4945 SEMINAR IN ECONOMICS (Variable hours 1-0 to 4-0) (V-0).
Study of a variety of topics of current interest in economics, to be determined by the instructor.

MN4970 SEMINAR IN ADMINISTRATIVE SCIENCE (Variable hours 1-0 to 4-0) (V-0).
Study of a variety of topics of general interest in the administrative sciences, to be determined by the instructor. PREREQUISITES: A background in administrative sciences and permission of the instructor.

MN4999 This course number indicates that a curriculum option should be selected.

DEPARTMENT OF AERONAUTICS AND ASTRONAUTICS

Chairman:
Daniel J. Collins
Professor
Code AA/Co, Halligan Hall
Room 139
(408) 656-2311
DSN 878-2311

Brij N. Agrawal, Professor of Aeronautics and Astronautics (1989)*; PhD, Syracuse University, 1970.

Robert E. Ball, Professor of Aeronautics and Astronautics (1967); PhD, Northwestern University, 1962.

Oscar Biblarz, Associate Professor of Aeronautics and Astronautics (1968); PhD, Stanford University, 1968.

M.S. Chandrasekhara, Adjunct Professor and Assistant Director, Navy-NASA Joint Institute of Aeronautics (1987); PhD, University of Iowa, 1983.

Daniel J. Collins, Professor of Aeronautics and Astronautics (1967); PhD, California Institute of Technology, 1961.

John A. Ekaterinaris, Adjunct Professor of Aeronautics and Astronautics (1988); PhD, Georgia Institute of Technology, 1987.

Sheshagiri K. Hebbar, Adjunct Professor of Aeronautics and Astronautics (1988); PhD, University of Maryland, 1976.

Garth Hobsen, Associate Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Richard M. Howard, Associate Professor of Aeronautics and Astronautics (1987); PhD, Texas A & M University, 1987.

Isaac I. Kaminer, Assistant Professor of Aeronautics and Astronautics (1992); PhD, University of Michigan, 1992.

Ramesh Kolar, Adjunct Professor of Aeronautics and Astronautics (1985); PhD, University of Arizona, 1984.

Gerald H. Lindsey, Professor of Aeronautics and Astronautics (1965); PhD, California Institute of Technology, 1966.

David W. Netzer, Professor of Aeronautics and Astronautics (1968); PhD, Purdue University, 1968.

Conrad F. Newberry, Professor of Aeronautics and Astronautics (1990); D.Env., University of California at Los Angeles, 1985.

Max F. Platzer, Professor of Aeronautics and Astronautics (1970); Dr. Tech. Science, Technical University of Vienna, Austria, 1964.

I. Michael Ross, Assistant Professor of Aeronautics and Astronautics (1990); PhD, Pennsylvania State University, 1990.

Louis V. Schmidt, Professor of Aeronautics and Astronautics (1964); PhD, California Institute of Technology, 1963.

Raymond P. Shreeve, Professor of Aeronautics and Astronautics (1971); PhD, University of Washington, 1970.

Joseph W. Sweeney III, Instructor of Aeronautics and Astronautics (1991); MS, Naval Postgraduate School, 1987.

E. Roberts Wood, Professor of Aeronautics and Astronautics (1988); D. Eng, Yale University, 1967.

Edward Ming-Chi Wu, Professor of Aeronautics and Astronautics (1984); PhD, University of Illinois, 1965.

*The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Aeronautics and Astronautics provides advanced education in Aeronautical and Astronautical Engineering to develop technical subspecialists in the field. Upper division undergraduate and graduate courses are offered in aerodynamics, structures, guidance and control, flight mechanics, propulsion and design, with applications to rotary wing and fixed wing aircraft, missiles and spacecraft.

Students specializing in either Aeronautical Engineering (Curriculum 610) or Aeronautical Engineering/Avionics (Curriculum 611) receive the degree Master of Science in Aeronautical Engineering, as well as select students in Weapons Systems Engineering (Curriculum 530). Students in the 530 curriculum may also get a Master of Science degree in Engineering Science with option in Aeronautics. A Master of Science degree in Astronautical Engineering is offered to students in Space Systems Engineering (Curriculum 591). Selected students may be eligible to pursue the degree Aeronautical and Astronautical Engineer or Doctor of Philosophy.

The Department of Aeronautics and Astronautics received a renewal of its full six (6) year accreditation from the Accreditation Board for Engineering and Technology in 1990.

REQUIREMENTS FOR STUDY OF AERONAUTICAL AND ASTRONAUTICAL ENGINEERING

The entrance requirement for study in the Department of Aeronautics and Astronautics generally is a baccalaureate in engineering earned with above-average academic performance. This requirement can be met by taking the equivalent of an undergraduate major in aeronautical engineering before embarking upon graduate study. This will require up to 2 1/2 years total to obtain the Master's degree. All entrants must obtain the approval of the Chairman, Department of Aeronautics and Astronautics. Students who have not majored in aeronautics, or who have experienced a significant lapse in continuity with previous academic work, will initially take preparatory courses in aeronautical engineering and mathematics at the undergraduate upper division level, which will extend through the first three academic quarters and constitute a portion of the course work for degrees in aeronautics. Final approval of programs leading to degrees in aeronautical engineering must be obtained from the Chairman, Department of Aeronautics and Astronautics.

Degree coverage specifically to be approved includes basic science, engineering science, adequate laboratory and computer experience, mathematics and design, including at least one capstone design course.

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

The Master of Science degree requires a minimum of 36-credit hours of graduate courses, of which at least 12-credit hours shall be at the 4000 level. It also requires that not less than 32 credit hours shall be in the disciplines of engineering, physical science or mathematics and that this shall include a minimum of 20 hours of courses in the

Department of Aeronautics and Astronautics and a minimum of 8 hours in other departments.

An acceptable thesis is required for the degree, and is waived in only very exceptional circumstances by the Chairman, Department of Aeronautics and Astronautics, in which case 10 quarter hours of 4000 level courses in the disciplines of engineering, physical science, or mathematics will be required in addition to those specified above, increasing the total requirements to 46 quarter hours of graduate-level credits.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students may elect Aeronautics or Astronautics as a specialization option and receive the degree Master of Science in Engineering Science. The program must include at least 36 credit hours of graduate work in engineering, science and mathematics, at least 12 of which must be at the 4000 level. Of these 36 hours at least 20, including work at the 4000 level, must be in the Department of Aeronautics and Astronautics. Cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Aeronautics and Astronautics.

The program must contain at least 12 hours at the graduate level in courses other than those presented in the Department of Aeronautics and Astronautics.

The candidate must present an acceptable thesis on a topic which is given prior approval by the Department of Aeronautics and Astronautics. Final approval of the program leading to the Master of Science in Engineering Science with specialization in Aeronautics or Astronautics shall be obtained from the Chairman of the Department of Aeronautics and Astronautics.

GRADUATE DEGREE IN CURRICULUM 591

Students of the Space Systems Engineering Curriculum (591) can elect specialization in astronautics and receive the Master's degree in Astronautical Engineering. This degree requires, in addition to courses specific to Curriculum 591, at least 20 credit hours of advanced coursework taken in the Department of Aeronautics and Astronautics. A minimum of 36 graduate credits, including at least 12 at the 4000 level and an acceptable thesis, are necessary. Not less than 32 graduate credits shall be in the disciplines of engineering, physical science or mathematics. Final approval of programs leading to this degree must be obtained from the Chairman, Department of Aeronautics an Astronautics.

AERONAUTICAL AND ASTRONAUTICAL ENGINEER

The degree Aeronautical and Astronautical Engineer is offered in the department of Aeronautics and Astronautics and requires a minimum of 72 hours of graduate course credit. The degree also requires a graduate QPR of 3.5, with hours distributed as follows: at least 39 credit hours must be at the 4000 level, of which at least three must be in mathematics; not less than 64 graduate credit hours shall be in the disciplines of engineering, physical science or mathematics; a minimum of 36 hours must be in the Department of Aeronautics and Astronautics and at least 12 hours must be in other departments. An acceptable thesis is required for the degree and six course equivalents, spread over four quarters, will be allowed in the program for it.

Formal application to work toward the degree must be made to the department of Aeronautics and Astronautics prior to commencement of thesis research and it is required that the applicant have a graduate QPR of 3.5, an approved program of study, a thesis advisor and an approved Engineer's Thesis research project.

Students admitted to work for the degree Aeronautical and Astronautical Engineer may satisfy requirements for the Master of Science in Aeronautical Engineering or the Master of Science in Astronautical Engineering degree concurrently. The respective master's degrees may be conferred at the time of completion of the requirements for that degree.

An appropriate allowance will be made for work performed while earning the master's degree at another institution, not to exceed the maximum waivers in required graduate

level courses specified in Section 240, paragraph 3 of the Academic Council Policy Manual. Final approval of the program leading to the degree Aeronautical and Astronautical Engineer shall be obtained for each student from the Chairman, Department of Aeronautics and Astronautics.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Aeronautics and Astronautics offers programs leading to the doctorate in the fields of gas dynamics, flight structures, flight dynamics, propulsion, aerospace physics and aerospace vehicle design.

Entrance into the doctoral program may be requested by officers currently enrolled in the Aeronautical and Astronautical Engineers Degree Program who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The Department of Aeronautics and Astronautics also accepts officer students selected in the Navy-wide Doctoral Study Program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Aeronautics and Astronautics shall submit transcripts of their previous academic and professional records to the Director of Admissions Code 62, Naval Postgraduate School, Monterey, California 93943-5100. Upon receipt, the application shall be reviewed by the Aeronautics and Astronautics Committee for Advanced Studies. Following a successful review, the candidate is admitted to work toward the Engineer's Degree as an interim step before being formally admitted to study for the doctorate. As soon as feasible, the student shall take a screening examination, which if successfully completed, will admit him or her to study for the doctorate. A doctoral committee will then be appointed to oversee the student's study and research program.

A distinctive feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are outlined in general school requirements for the doctor's degree.

In the event that a student is unable to finally satisfy the above requirements for the doctorate, but has in the course of his or her doctoral studies actually completed all of the requirements for the degree of Aeronautical Engineer, he or she shall be awarded the latter degree.

AERONAUTICAL LABORATORIES

Eight major laboratory divisions support instructional and research programs in subsonic aerodynamics, gas dynamics, rocket and ramjet propulsion, turbomachinery, computer-aided engineering, flight mechanics, structures, composite materials and space systems.

The Subsonic Aerodynamics Laboratory consists of two low-speed wind tunnels, a large continuous-flow visualization tunnel and a 15x20 inch water tunnel. Standard wind tunnel techniques are used in the 32x45 inch and 42x60 inch tunnels and helium bubble filaments are used in the 5x5x12 foot test section of the three-dimensional flow visualization tunnel.

The Gas Dynamics Laboratory includes a 4x4 inch blowdown supersonic wind tunnel, a cold driven, three-inch double-diaphragm shock tube, a 2x2x18 foot open-circuit oscillating flow tunnel and a vertically mounted, supersonic free jet. Laser interferometers, schlieren systems, hot wire anemometry and laser-doppler anemometers are used. Ruby, He-Ne, Argon and CO lasers are available. Extensive use is made of laser holography. An electro-hydrodynamic research facility permits studies of electric power generation, turbulence and fuel sprays into gas turbine combustors.

The Combustion Laboratory consists of an instrumented control room, a propellant evaluation laboratory, a high-pressure air facility and three test cells equipped with

diagnostic apparatus and motor hardware for investigating solid, liquid, gaseous and hybrid rocket, solid fuel ramjet and gas turbine combustion. Vitiated air heaters are used to generate temperatures to 1300°F. Several CW and one pulsed laser with holocamera, high-speed motion picture cameras, light scattering and transmission measurement systems, schlieren systems, sampling probes and a dark room equipped for holographic reconstruction and data retrieval are utilized.

The Turbo-Propulsion Laboratory (TPL) houses a unique collection of experimental facilities for research and development related to compressors, turbines and advanced air-breathing propulsion engine concepts. In a complex of specially designed concrete structures, one building, powered by a 750 HP compressor, contains 10x60 inch rectilinear and 4 to 8 foot diameter radial cascade wind tunnels and a large 3-stage axial research compressor for low speed studies. A two-component, automated traverse, LDV system is available for CFD code verification experiments. A second building, powered by a 1250 HP compressed air plant, contains fully instrumented transonic turbine and compressor rigs in explosion proof test cells. A spin-pit for structural testing of rotors to 50,000 RPM and 1800°F is provided. Model experiments and equipment for instrumentation development are located in a separate laboratory. Data acquisition from 400 channels of steady state and 16 channels of non-steady state measurements at up to 100kHZ is controlled by the laboratory's HP 1000 series computer system. On-line reduction and presentation of data with time sharing terminals are available to multiple users. Terminals for HP 9845 and the central AMDAHL 5990-5N computers are available for data analysis or flow computation.

The Computer-Aided Design / Computer-Aided Engineering (CAD/CAE) Laboratory has twelve 32-bit networked CAD/CAE VAX workstations, twenty-four microcomputer systems and two computer-controlled data acquisition systems.

The Flight Mechanics Laboratory consists of a general-aviation flight simulator and the Unmanned Air Vehicle Flight Research Laboratory (UAV FRL). The simulator is used for teaching flight test engineering. The UAV FRL conducts flight research with scaled radio-controlled aircraft to study problems identified with current fleet UAVs and to test new concepts for manned and unmanned aircraft application. Research vehicles include fixed-wing, VTOL and rotary wing aircraft. The department's wind tunnels are also used for aircraft performance, stability and control measurements.

The Structural Test Laboratory contains testing machines for static and dynamic tests of materials and structures and a MTS electrohydraulic closed-loop machine for fatigue testing. Aircraft components as large as an actual aircraft wing are accommodated on a special loading floor where static and vibration tests are conducted. An adjacent strain gage and photo-elastic facility provides support to test programs and instruction in structural testing techniques.

The Mechanics of Materials for Composites Laboratory is equipped with fabrication and testing facilities for characterizing the mechanical behavior of fiber-reinforced composites. The fabrication facilities include an oven and press with provisions for computer control of temperature and pressure profile for fabrication of laminates and strands. The testing facilities include five mechanically driven universal testing machines for general testing and for life testing. These testing facilities are supported by a wide array of modern data acquisition instruments including computer- controlled data loggers, digital voltmeters, acoustic emission analyzer and laser diffraction instruments. Personal computers and a VAX-725 provide ample capacity for analytical interpretation of data and for model formulation.

The Dynamics and Nondestructive Evaluation Laboratory is equipped for research on vibration of structures, particularly lightweight components for space structures made from composite materials like graphite/epoxy. It contains shaker tables, a four channel FFT analyzer, microcomputers with model analysis software and associated accelerometer instrumentation. For the study of wave propagation in these structures, the laboratory

has high-speed transient recorders, narrow and wideband transducers, pulse generators and an arbitrary waveform generator. Static and fatigue loading of samples can be carried out on the 100 kip servo hydraulic MTS machine. The detection of flaw growth during a test can be accomplished using the acoustic emission analyzer. A 2x4 foot ultrasonic C-scan tank can be used for post-test imaging of internal damage. Phase locked loop and quadrature phase detector circuitry allow precise spatial location of flaws. This instrumentation can also be used for very accurate wavespeed measurements.

The Controls Laboratory presently consists of five experimental apparatuses with associated computers and graphic interfaces. Each experiment is a physical device which possesses, for example, input limitations, hysteresis effects and dead-space, among other effects. A computer interface and software program permits the design of a wide range of controllers for the experiments. The purpose of the laboratory is to improve understanding of control theory by design of controllers for physical devices.

SPACECRAFT LABORATORIES

There are three spacecraft laboratories within the department, viz., the FLTSATCOM laboratory, the Spacecraft Test Laboratory, and the Spacecraft Attitude Dynamics and Control Laboratory. The FLTSATCOM laboratory houses a qualification model of the Navy's communication satellite (which provides global UHF coverage) along with the associated hardware and software used to test the satellite's subsystems. The test laboratory contains a vibration shaker system and a thermal vacuum chamber system. The former is used for testing typical vibration loads on a spacecraft, and is capable of simulating both low frequency (swept sinusoidal) and random vibrations. The latter is used to test the operation of spacecraft materials/subsystems under the combined conditions of space vacuum (below 10^{-5} torr) and thermal environment. The third laboratory contains a scaled model of a generic flexible spacecraft and simulates the pitch motion. It is used to study the interaction between the attitude control and the dynamics of flexible spacecraft, where the flexibility may be due to structures and/or liquid propellants.

NAVY-NASA JOINT INSTITUTE OF AERONAUTICS

Through a Memorandum of Understanding with the Ames Research Center (ARC) of the National Aeronautics and Space Administration (NASA), a Joint Institute of Aeronautics was established in July 1986. The purpose of the Institute is to provide NPS students with opportunities to perform their thesis research in an ARC Laboratory, to involve NPS faculty and students in NASA scientific and engineering projects, to develop special courses and seminars for NPS and ARC scientists and engineers to refresh and strengthen professional knowledge at NPS and ARC, and to encourage the enrollment of federal employees for graduate study at NPS with the possibility of performing the thesis research at ARC. Information about research opportunities and admission procedures can be obtained from the Institute Director, Dr. M.F. Platzer, or the Assistant Director, Dr. M.S. Chandrasekhara.

COURSE OFFERINGS

AE0020 AERONAUTICAL ENGINEERING PROGRAM PLANNING (NO CREDIT) (0-1).

Oral presentations to students by the department faculty covering thesis research specialty areas in Aeronautical Engineering.

AE0810 THESIS RESEARCH (0-0).

Every student conducting thesis research will enroll in this course.

AE2015 ENGINEERING DYNAMICS (3-2).

Kinematics and dynamics of particles, systems of particles and rigid bodies in two dimensions; concepts of work, kinetic energy, potential energy, impulse and momentum. PREREQUISITES: MA2121 and ME2501.

AE2021 INTRODUCTION TO FLIGHT STRUCTURES (4-1).
Stress analysis methods for aircraft structures, covering field equations for solid bodies, bending stress and shear flow due to transverse and torsion loads in open and closed sections. Multicell wing and fuselage structures are analyzed, including the effects of taper. PREREQUISITE: ME2601

AE2035 BASIC AERODYNAMICS (3-2).
Continuity/momentum equations; dimensional analysis; elements of two dimensional ideal flow; thin-airfoil, finite wing theory. PREREQUISITE: AE2042.

AE2036 PERFORMANCE AND STATIC STABILITY (3-2).
Model atmosphere; defined airspeeds; aircraft performance including thrust and power required, climb, range, endurance and energy management; principles of longitudinal, lateral and directional static stability and control of aircraft. PREREQUISITE: AE2035.

AE2042 FUNDAMENTALS OF THERMO AND FLUID DYNAMICS (3-2).
Properties of fluids; first and second laws of thermodynamics; entropy and irreversibilities; equations of state; properties of pure substances. Principles of continuity, momentum and energy for incompressible and compressible fluids; control volume formulations; power cycles. Viscous flows in ducts; boundary layer concepts; flow separation and drag. PREREQUISITE: MA2121.

AE2043 FUNDAMENTALS OF GAS DYNAMICS (3-2).
Concepts of compressible flows, adiabatic/isentropic flow; normal shocks, moving and oblique shocks, Prandtl-Meyer flow; Fanno and Rayleigh flow; introduction to reaction propulsion systems. PREREQUISITE: AE2042.

AE2440 INTRODUCTION TO DIGITAL COMPUTATION (3-2).
Introduction to system operations and program development on the AA department computer systems and the NPS mainframe. Programming methods and languages will be illustrated in the solutions of non-linear equations, polynomial interpolations, and numerical integration and differentiation techniques as found in aeronautical engineering. UNIX operating system will be introduced.

AE2801 AERO-LABORATORIES (3-2).
An introduction to modern experimental techniques and instrumentation. Lectures and demonstrations in the use of sensing devices and data acquisition systems, data reduction and analysis, report writing. Selected experiments in all aeronautical laboratories. PREREQUISITES: AE2021, 2035, 2043 and 2015 (concurrent) or equivalent.

AE2820 INTRODUCTION TO SPACECRAFT STRUCTURES (3-2).
Loads criteria for space vehicles: launch, on-orbit, maneuver and thermal. Field equations, strain-displacement, equilibrium and constitutive equations. Materials for space structures. Design criteria. Structural modeling of large flexible space trusses and other components. Analysis of typical members.

AE3005 SURVEY OF AIRCRAFT AND MISSILE TECHNOLOGY (Intended for Non-Aero. Engineering Students). (4-0).
A survey of aeronautical engineering concepts as applied to airplanes and missiles, starting with explanations of the basic principles of aerodynamics, performance, propulsion, etc. and extending to examples of these principles in present-day hardware.

AE3101 FLIGHT VEHICLE STRUCTURAL ANALYSIS (3-2).
A graduate core course in structures covering work and energy principles; deformation and force analysis methods; and an introduction to the finite element method.

AE3251 AIRCRAFT COMBAT SURVIVABILITY (4-1).
This course brings together all of the essential ingredients in a study of the survivability of fixed wing aircraft, rotary wing aircraft and cruise missiles in a hostile (non-nuclear) environment. The technology for increasing survivability and the methodology for assessing the probability of survival in a AAA/SAM/Laser environment are presented in

some detail. Topics covered include: current and future threat descriptions; the mission/ threat analysis; combat data analysis of SEA and Mid-East losses; vulnerability reduction techniques and technology for the major aircraft systems; susceptibility reduction concepts, including stealth; vulnerability, susceptibility and survivability assessment and trade-off methodology, and system safety. In-depth studies of the survivability of several fixed wing and rotary wing aircraft will be presented. (May be taken for 3 credits through self study as AE3250). PREREQUISITES: U.S. citizenship and SECRET clearance.

AE3276 INTRODUCTION TO AVIONICS (3-2).
This course will discuss the avionics equipment found in military and civilian aircraft, with a particular emphasis on navigation, communication and vehicular management systems. Radar and EW concepts will be briefly covered. Avionics concepts will be described in both analog and digital formats. Topics will include data bus architectures, failure mode analysis, software validation and environmental and maintenance considerations.

AE3340 DYNAMIC STABILITY OF AEROSPACE VEHICLES (3-2).
Free and forced response of physical systems; eigenvalue problem solutions for damped/ undamped systems. Stability derivatives including the effects of elasticity; aircraft equations of motion; state variable solutions for uncoupled and cross-coupled cases. PREREQUISITES: AE2015, AE2036.

AE3341 CONTROL OF AEROSPACE VEHICLES (3-2).
Classical control theory including Bode, Nyquist and root-locus concepts as applied to aircraft, missiles and space structures. Auto-pilot design and stability augmentation using modern control theory up to observer theory concepts. The effect of noise excitation on controller design with emphasis on aircraft gust response. PREREQUISITE: AE3340.

AE3402 HELICOPTER STABILITY AND CONTROL (3-2).
This course replaces AE3340 for students pursuing rotorcraft option. Rotorcraft general equations of motion. Rotor blade forces and motions in hover and forward flight. Derivation of trim equations and stability derivatives. Rotorcraft static and dynamic stability characteristics. Routh's discriminant. Control response. MIL-H-8501A and ADS-33 helicopter handling quality requirements. Control system design. PREREQUISITES: AE2015, AE2036.

AE3451 AIRCRAFT AND MISSILE PROPULSION (3-2).
Introduction to solid rocket propulsion including propellant selection and performance and nozzle flow analyses. Description, design criteria, on-and off-design cycle analysis and performance of ramjets, turboprops, turbojets and turbofans. Analysis of components: inlets, compressors, combustors, turbines, afterburners and nozzles. Current state-of-the-art and impact of trends in propulsion technology. PREREQUISITE: AE2043.

AE3501 AERODYNAMIC ANALYSIS (3-2).
Introduction to aerodynamic analysis methods for subsonic and supersonic flight vehicles. Developments proceed from the three-dimensional Navier-Stokes equations to various approximation methods for linearized, inviscid, subsonic and supersonic flows over airfoils and wings; discussion of sweep-back effects and area ruling; introduction to DATCOM methods; laminar and turbulent boundary layer analysis; use of computer programs based on panel, vortexlattice and other methods. PREREQUISITES: AE2043, AE2035, MA3132.

AE3701 MISSILE AERODYNAMICS (4-1).
Potential flow, thin-airfoil and finite wing theories. Linearized equations, Ackeret theory, Prandtl-Glauert transformations for subsonic and supersonic wings. Planform effects. Flow about slender bodies of revolution, viscous crossflow theory. PREREQUISITE: AE2043.

AE3705 AIR DEFENSE LETHALITY (4-1).
This course examines the design and effectiveness of anti-aircraft guns and missiles, both surface based and airborne. The techniques and procedures for target detection, target tracking and propagator flyout (both guided and ballistic) are presented and quantified.

Target signatures for radar, IR and visually directed systems are examined. The types of warheads and fuzes on small arms, anti-aircraft artillery and guided missiles are presented. The vulnerability of the target to the damage mechanisms is examined and the procedures for assessing the measures of target vulnerability are described. Total system lethality is evaluated by determining the probability of target kill given a single shot and given an encounter. Countermeasures used by the target for reducing the air defense lethality are also described.

AE3712 SURVEY OF TACTICAL MISSILE SYSTEMS (Intended for Non-Aero. Engineering Students) (3-2).
Overiew of missile performance and design criteria, stressing decision making in the design process, supplemented with the basics of aerodynamics, propulsion, guidance, control, sensors and warheads.

AE3802 AERONAUTICAL MEASUREMENT TECHNIQUES (3-3).
This course is intended to introduce the student to aeronautical measuring techniques and test facilities used by NASA and the aerospace industry during the research, development and testing phase (RDT&E) of aircraft and missile systems. Applications of laser-doppler velocimetry, hot wire instrumentation, flow visualization methods and modern data acquisition systems will be demonstrated. Field trips to NASA Ames Research Center will be arranged to show how the advanced techniques and facilities are applied to solve real-world problems in aeronautics. PREREQUISITE: AE2801.

AE3804 THERMAL CONTROL OF SPACECRAFT (3-0).
Fundamentals of thermal radiation. Vehicle equilibrium temperature. Effects of coatings and of orbit, on vehicle temperature; the transient case (earth shadow). Heat rejection systems: free-space and non-free-space. Weight optimizations. Effect of manifolds. Design and synthesis examples. PREREQUISITE: AE2840.

AE3811 SPACE SYSTEMS LABORATORY (1-2).
This course consists of lectures on basic principles of spacecraft testing and experiments on spacecraft sinusoidal testing, random testing, thermal vacuum testing, FLTSATCOM closed loop attitude control testing and selected spacecraft system functional testing.

AE3815 INTRODUCTION TO SPACECRAFT DYNAMICS (3-2).
Rotating coordinates; orientation angles. Velocities, accelerations; motion equations. Attitude stabilization considerations. Three axis control. PREREQUISITES: AE2015 and AE2820.

AE3850 PROPULSION FOR LAUNCH VEHICLES (4-0).
Introduction to propulsion for launch vehicles, beginning with mission energy requirements and an overview of current and proposed launch propulsion devices. Performance analysis, operating characteristics and propellant selection criteria are considered for airbreathing and solid, liquid and nuclear rocket motor propulsion systems. PREREQUISITES: AE2042, AE2043, AE3851.

AE3851 SPACECRAFT PROPULSION (3-2).
This course introduces concepts and devices in spacecraft propulsion. It reviews fundamental fluid mechanics, electricity and magnetism and thermodynamics with molecular structure. Conventional chemical means such as H2/O2 and monopropellants are discussed. Electric propulsion schemes (resistojets, arc-jets, ion, magneto-plasma-dynamic, etc.) are introduced and their performances contrasted with chemical schemes. Characteristics of more advanced concepts (laser, microwave, solar, thermal, etc.) are also considered.

AE3900 SPECIAL TOPICS IN AERONAUTICS (Variable hours 1-0 to 5-0) (V-0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of department Chairman.

AE4000 AERONAUTICAL ENGINEERING SEMINAR (1-0).
Oral presentations on subjects not covered in formal courses, which treat a wide spectrum of topics ranging from reports of current research to survey treatments of Navy issues and problems of scientific and engineering interest.

AE4102 FINITE ELEMENT ANALYSIS OF FLIGHT VEHICLES (3-2).
The finite element method of structural analysis is formulated and applied to aircraft, missile and space structures. Element properties for bars, frames, membranes, plates/shells and three dimensional solid elements are discussed. Structural idealization, modeling and interpretation of results are presented. Capabilities of commercial finite element codes and pitfalls of computation are reviewed. Basics of nonlinear analysis are presented. PREREQUISITE: AE3101.

AE4103 MECHANICS OF COMPOSITE MATERIALS (3-2).
A course covering the mechanics of multi-phased composite materials. Prediction of composite properties from the constituent of fiber/matrix properties. Design of composite structural components including laminates and sandwich construction. Fabrication and manufacturing techniques. Survey of strength theory, damage and repair. PREREQUISITE: AE3101 or ME3611.

AE4201 RELIABILITY ENGINEERING AND SYSTEM SAFETY MANAGEMENT (4-0).
An introduction to System Safety based on the foundations of statistical sampling and probability modeling with applications to military standard requirements. Mathematical foundations (probability, set theory, Boolean algebra, distribution functions); reliability testing (experimental planning via Monte Carlo simulations, parameter estimation); safety analysis (hazard analysis, fault-tree analysis, monolithic and redundant components) safety criteria and life cycle considerations.

AE4202 RELIABILITY OF COMPOSITE MATERIALS (3-2).
A course covering the reliability engineering of composite materials in critical structural applications. Probability modeling of strength of composites, prediction of geometric size effect, development of standards for specification and acceptance. Reliability assurance methodology, proof-test, life predictions. Structure reliability under combined state of stress, damage repair and inspections. PREREQUISITE: AE4201.

AE4273 AIRCRAFT DESIGN (3-2).
A course in conceptual design methodology which centers around an aircraft student design team project. It draws upon all of the aeronautics disciplines and provides the student with experience in their application to design. Consideration is given to trade-offs around performance requirements, propulsion, aerodynamics, structures, quality, stability, control and cost. PREREQUISITES: AE2021, AE2035, AE2036, AE3341, AE3451.

AE4276 AVIONICS SYSTEM DESIGN (3-2).
This course will develop digital control concepts for aircraft applications; methodology of designing a digital flight control system for a high performance aircraft; review of sensor and actuator characteristics. A detailed case study of a digital flight control system will be performed by students.

AE4278 AERODYNAMIC DESIGN (3-2).
This course introduces the student to the current methods used for aerodynamic design of aircraft, missiles and helicopters, and applies these methods to specific configurations. PREREQUISITES: AE2035, AE3501.

AE4304 HELICOPTER DYNAMICS AND AERODYNAMICS (3-2).
Aerodynamics of helicopters. Hover and vertical flight. Actuator disk, momentum theory, blade element theory, tip loss, rotor flow states, autorotation, hover and forward flight analysis and performance analysis. Helicopter dynamics, rotor blade motion and control, vibrations, rotor as a filter, coupled blade-fuselage response, mechanical and aerodynamic

instabilities, vibration control devices, higher harmonic control, rotor acoustics accounting for rotational, vortex and BVI noise. PREREQUISITE: AE3501.

AE4305 V/STOL AIRCRAFT TECHNOLOGY (3-2).
Types of V/STOL aircraft, fundamental principles, main performance characteristics and propulsion requirements; STOL technology: mechanical high-lift devices, powered-lift devices, jet flaps, augmentor wings; VTOL technology: flow vectoring devices, lift engine and lift fan technology, augmentor wings, airframe/propulsion system interactions, ground interference effects; V/STOL stability and control considerations, handling qualities; review of current NAVY V/STOL requirements and programs. PREREQUISITES: AE3501, AE3451, AE3340.

AE4306 HELICOPTER DESIGN (3-2).
Design of a helicopter to meet given mission requirements. Students participate with instructor and visiting guest lecturers in helicopter design process. Topics include rotor dynamics, selected subjects in helicopter design, design lessons learned from AH-64 "Apache," helicopter vibrations, handling quality requirements, dynamic NASTRAN, survivability/killability, Navy driven design requirements, Navy rotocraft into 21st century and lessons from Soviet helicopter technology. PREREQUISITE: AE4304.

AE4317 FLIGHT VEHICLE STRUCTURAL DYNAMICS (4-0).
Response of single and multi degree-of-freedom systems; vibrations of rods and beams. Finite element formulation for structural dynamics problems in fixed-wing and rotary wing aircraft, flexible spacecraft and large space structures. Computational methods for dynamic response. Introduction to nonlinear vibrations and chaos. PREREQUISITES: MA2121, MA2047.

AE4318 AEROELASTICITY (4-0).
Response of discrete and continuous elastic structures to transient loads and to steady oscillatory loads. Static aeroelasticity, non-stationary airfoil and wing theory. Unsteady missile aerodynamics. Application to the flutter problem. Transient loads, gusts, buffet and stall flutter. PREREQUISITE: AE3340.

AE4323 FLIGHT TEST ENGINEERING (3-2).
Flight test analysis for pitot-static calibration, cruise and climb performance, stall testing, longitudinal static and dynamic stability, maneuvering stability, lateral-directional stability, transonic flying qualities and helicopter flight testing. Includes a week-long in-flight laboratory. PREREQUISITE: AE2036.

AE4342 ADVANCED CONTROL FOR AEROSPACE SYSTEMS (3-2).
Linear optimal control, Kalman Filter techniques. Elements of H2 and H-infinity design applied to modern tactical fighters and spacecraft structures. Topics may include: sliding mode controllers, distributed controllers and/or adaptive estimators. PREREQUISITE: AE3341.

AE4431 TURBOMACHINES: ANALYSIS, DESIGN AND EXPERIMENT (3-2).
The underlying principles governing flow through and energy exchange in compressors and turbines are developed to provide a basis for understanding both design and current analysis methods. Key considerations and procedures followed in the design of aircraft engine compressors and turbines are described and current computational methods of analysis are introduced. Lectures are coordinated with experimental experience at the Turbopropulsion Laboratory. PREREQUISITE: AE2043.

AE4451 AIRCRAFT ENGINE DESIGN (3-2).
The design process, aircraft-engine constraints, mission constraints, on-design and off-design cycle analysis, engine sizing for installed performance, component designs (fans, compressors, turbines, burners, inlets, exhaust nozzles). PREREQUISITE: AE3451.

AE4452 TACTICAL MISSILE PROPULSION (4-0).
Applications and analysis of solid propellant rockets, ramjets, dual-mode ramjets and ducted rockets. Propellant selection criteria and characteristics, combustion models and behavior, performance analysis, combustor design, combustion instabilities and damping, mission and flight envelope effects on design requirements and technology requirements. Introduction to insensitive munitions and plume signature considerations. PREREQUISITES: AE2042 or PH2724, AE2043.

AE4502 HIGH-SPEED AERODYNAMICS (4-0).
Transonic aerodynamics; numerical solutions to potential equations; airfoil analysis; shock-capturing. Method of characteristics; development of system of partial differential equations. Numerical problems in transonic and supersonic flows. PREREQUISITE: AE3501.

AE4503 MISSILE AERODYNAMICS (4-0).
The aerodynamics of missiles and guided projectiles for various speed regimes and motions. Topics include slender body and linearized theory as well as nonlinear aerodynamic effects, coupling effects, Magnus effects, etc. The impact of these effects on missile flight dynamics, guidance and control is included. PREREQUISITE: AE3501.

AE4504 CONVECTIVE HEAT AND MASS TRANSFER (4-0).
Convective heat and mass transfer in laminar and turbulent flows. Analytic techniques, integral and numerical methods, experimental correlations. Effects of variations in thermophysical properties. PREREQUISITE: AE3501.

AE4505 LASER/PARTICLE BEAM TECHNOLOGIES (3-2). Elements of lasers and particle beams are presented together with a survey of their technologies. High energy lasers, including electrical, gas dynamic, excimer and chemical lasers, as well as electron beams are typically treated. Concepts in beam management, propagation and damage mechanisms are discussed. Current military applications and future trends are covered as special topics. PREREQUISITE: AE2043.

AE4506 RAREFIED GAS DYNAMICS (4-0).
Topics include advanced thermodynamics with molecular structure, kinetic theory, distribution functions, Boltzmann equation and transport phenomena from a kinetic theory point of view. Types of flow range from free-molecule to transition, to high temperature continuum. Numerical approaches are discussed. PREREQUISITES: AE2042, AE2043, AE3501 and AE4632.

AE4507 COMPUTATIONAL FLUID DYNAMICS AND HEAT TRANSFER (3-2).
The emphasis will be on the numerical solution of sets, of partial differential equations, that describe fluid flow and heat transfer. The governing equations for fluid dynamics are reviewed and turbulence modelling is introduced. Discretization techniques are applied to selected model equations and numerical methods are developed for inviscid and viscous, compressible and incompressible flows. PREREQUISITE: AE4632.

AE4632 COMPUTER METHODS IN AERONAUTICS (3-2). Numerical methods in aeronautical engineering problems. Computer solution procedures for ordinary and partial differential equations. PREREQUISITES: AE2440, MA3132.

AE4641 AERONAUTICAL DATA SYSTEMS (3-2).
A design-project-oriented course utilizing microprocessor technology with emphasis upon aeronautical engineering applications. Both software and hardware aspects of system integration will be considered for engineering tradeoffs during problem definition and solution. PREREQUISITE: EC2170 or equivalent.

AE4650 PARALLEL DISTRIBUTED PROCESSING (NEURAL NETWORKS) (4-0).
Analysis of paradigms associated with neural networks using extensive computer software to test and develop applications. The main emphasis of the course is to develop an understanding of neural networks and the applications of neural network techniques to a variety of problems including image identification. PREREQUISITE: Consent of instructor.

AE4703 MISSILE FLIGHT ANALYSIS (4-1).
Stability and control. Configuration determinants. Transient (dynamic) modes. Subsonic, transonic, supersonic force and moment data for performance calculations with short and long-range cruciform missiles and cruise missiles: acceleration, climb, ceiling, range and agility in maneuvering trajectories. PREREQUISITE: AE3701

AE4704 MISSILE DESIGN (3-2).
Conceptual missile design methodology centered around a student design team project. It stresses upon all of the aeronautics disciplines, including aerodynamics, propulsion and flight mechanics, and provides the student with their application to design. Consideration is given to trade-offs among propulsion requirements, air loads, quality sensors, guidance laws, quality, controls and structural components. PREREQUISITES: AE3701, AE4452 and AE4703.

AE4712 SURVEY OF TACTICAL MISSILE SYSTEMS (Intended for Non-Aero. Engineering Students) (3-2).
Overview of missile technology: air loads, propulsion, guidance and control and sensors. Simple trajectory analysis. Performance tradeoffs.

AE4816 DYNAMICS OF FLEXIBLE SPACE STRUCTURES (4-0).
Characterization of periodic and random structural vibrations encountered in space systems. Physical coordinates and modal coordinates. Mass, stiffness and damping matrices. Single degree-of-freedom and multiple degree-of-freedom systems. Forced response analysis. The general mobility matrix. System identification by input-output relations. Random excitation and autospectral density. Problems associated with parameter estimation. Introduction to nonlinear systems.

AE4818 SPACECRAFT ATTITUDE, DYNAMICS AND CONTROL (4-0).
This course covers effects of energy dissipation on attitude stability, dynamic effects of liquified motion, spacecraft disturbance torques, active mutation control of spin-stabilized spacecraft, attitude sensors, three-axis stabilization, fixed momentum wheel system, skewed momentum wheel/reaction wheel system, structural flexibility/control interactions, modal observability controllability, modal truncation and attitude control design examples. PREREQUISITE: AE3815.

AE4830 SPACECRAFT SYSTEMS I (Intended for curriculum 366) (3-2).
Examination of the factors affecting space systems selection and design, impact of orbital and sensor characteristics, ground facilities requirements, manufacturing, testing and verification techniques and requirements. Payload design considerations including impact of antennas. RF environment and EMI. Mechanical and electrical design of space systems. Temperature control. Attitude control. Special techniques associated with large space structures. PREREQUISITES: PH3514, completion of Space Engineering Core Curriculum or equivalent.

AE4831 SPACECRAFT SYSTEMS II (Intended for curriculum 366) (3-2).
Survivability of space systems in wartime is discussed along with design features to improve protection. Case studies are selected to emphasize and illustrate material presented previously in AE4830 as well as material in AE4831. The students design a space system to meet mission requirements. PREREQUISITE: AE4830.

AE4844 HYPERSONIC FLIGHT (4-0).
Characteristic features of flow over re-entry and hypersonic flight vehicles. Effects of Mach number, high enthalpy and low density. Analysis and computational methods for blunt and slender bodies and for practical vehicle shapes. Ground simulation of re-entry and sustained flight environments. The hypersonic air-breathing vehicle. PREREQUISITES: AE2035 and AE2043.

AE4870 SPACECRAFT DESIGN AND INTEGRATION (4-0).
This course concentrates on the overall design aspects of the spacecraft bus. Emphasis is

on the integration of sub-systems, test procedures and space qualifications to meet specific mission requirements. PREREQUISITE: Completion of Space Engineering Curriculum Core.

AE4871 SPACECRAFT DESIGN AND INTEGRATION II (4-0).
A design-project course concentrated on detailed application of design of spacecraft bus sub-systems, including hardware selection and location and integration into spacecraft configuration. PREREQUISITE: AE4870.

AE4900 ADVANCED STUDY IN AERONAUTICS (Variable hours 1-0 to 5-0) (V- 0).
Directed graduate study or laboratory research. Course may be repeated for additional credit if topic changes. PREREQUISITE: Consent of department Chairman.

ANTISUBMARINE WARFARE ACADEMIC GROUP

Chairman:
Jim Eagle
Professor
Code AW, Spanagel Hall
Room 202
(408) 656-2433
DSN 878-2433

Robert Hathaway Bourke, Professor of Oceanography (1971)*; BS, Naval Academy, 1960; MS, Oregon State University, 1969; PhD, Oregon State University, 1972.

Ching-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Alan Berchard Coppens, Associate Professor of Physics (1969); B. ENG.PHY, Cornell University, 1959; MS, Brown University, 1962; PhD, Brown University, 1965.

James Norfleet Eagle, II, Professor of Operations Research (1973); PhD, Stanford University, 1975.

James H. Miller, Associate Professor (1987); ScD, Massachusetts Institute of Technolgy and Woods Hole Oceanographic Institution, 1987.

James Vincent Sanders, Associate Professor of Physics (1961); BS, Kent State University, 1954; PhD, Cornell University, 1961.

Clyde Scandrett, Associate Professor (1987), PhD, Northwestern University, 1985.

Charles William Therrien, Professor (1984); SB and SM, Massachusetts Institute of Technology, 1965; PhD, Massachusetts Institute of Technology, 1969.

Alan Robert Washburn, Professor (1970); PhD, Carnegie Institute of Technology, 1965.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Academic Associate:
James Sanders, Associate Professor
Code PH/Sd, Spanagel Hall, Room 146B
(408) 656-2931, DSN 878-2931

The Antisubmarine Warfare Academic Group is an association of faculty members representing separate academic disciplines. An academic group is a less formal organization than an academic department and each professor in the group has an appointment in an academic department. The Antisubmarine Warfare Academic Group has administrative responsibility for the academic content of the Antisubmarine Warfare program of study. Teaching in this interdisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, National Security Affairs, Oceanography, Operations Research and Physics.

MASTER OF SCIENCE IN APPLIED SCIENCE

The degree Master of Science in Applied Science will be awarded at the completion of the multidisciplinary program.

The entire program must be approved by the Chairman of the Antisubmarine Warfare Group.

COURSE OFFERINGS

ST0001 SEMINAR (0-1).
Special lectures and discussion of matters related to the ASW Program.
PREREQUISITES: Enrollment in the ASW Curriculum and SECRET clearance.

ST0810 THESIS RESEARCH/GROUP PROJECT (0-0).
Students in the ASW Curriculum will enroll in this course while doing either an individual thesis or an equivalent group project involving several students and faculty.

ST3000 STUDY PROJECT ON ASW SYSTEMS PERFORMANCE (0-2).
This is a project course in which the project is a study and analysis of the performance of an assigned type of ASW system under a variety of operating conditions.
PREREQUISITES: Enrollment in the ASW Curriculum or consent of the group Chairman and SECRET clearance. Graded on a Pass/Fail basis only.

ST4999 SPECIAL STUDIES IN ASW (Variable hours 1-0 to 4-0) (V-0).
A course designed to meet the needs of students for special work in advanced topics related to ASW. PREREQUISITES: Enrollment in the ASW curriculum and consent of the group Chairman.

Richard J. Toft, CAPT, U.S. Navy; Director (1990)*; BS, Rutgers University, 1962.

Milton Harold Bank, II, Associate Professor of Aeronautical Engineering and Safety (1971); PhD, Georgia Institute of Technology, 1971.

Steven Bulwicz, LCDR, U.S. Navy; Instructor in Mishap Investigation (1990); BA, Jersey City State College, 1974.

Anthony P. Ciavarelli, Jr., Associate Professor of Psychology (1989); Ed.D., University of Southern California, 1988.

Steven P. Grohsmeyer, LtCol, U.S. Marine Corps; Instructor in Rotary-Wing Aerodynamics (1991); AeE, Naval Postgraduate School, 1990.

Thomas R. Hazard, Maj, U.S. Marine Corps; Instructor in Aviation Safety Information Management (1992); MSSM, University of Southern California, 1976.

Edward John Kennedy, Adjunct Professor of Aviation Physiology (1972); MD, University of Iowa College of Medicine, 1962.

L. Kron Littleton, Jr., CDR, U.S. Navy; Instructor in Aviation Safety Programs (1992); BS, Appalachian State University, 1970.

Richard E. Oswald, Jr., LCDR (MC), U.S. Navy; Assistant Professor of Aerospace Medicine (1991); DO, Chicago College of Osteopathic Medicine, 1983.

Robert S. Paskulovich, LCDR, U.S. Navy; Instructor in Fixed-Wing Aerodynamics (1992); AeE, Naval Postgraduate School, 1987.

David J. Thorn, LCDR, U.S. Navy; Instructor in Mishap Investigation (1991); BS, University of Oklahoma, 1974.

Frank P. Yasment, CDR, U.S. Navy; Instructor in Aviation Safety Programs (1989); MBA, National University, 1985.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

AVIATION SAFETY OFFICER COURSE

An Aviation Safety Officer (ASO) course is offered seven times each year on a temporary additional duty basis for those commands needing an Aviation Safety Officer. This course prepares the graduate to assist his or her commanding officer in conducting an aggressive mishap prevention program. When the ASO completes the course he or she will be able to organize and administer a mishap prevention program at the squadron level as defined in OPNAVINST 3750.6.

This twenty-eight day course consists of approximately 146 classroom and laboratory hours, plus a two-day field trip. Subjects addressed in the classroom and laboratory include safety programs, mishap prevention techniques, operational aerodynamics and aerostructures, mishap investigation and reporting, psychology, safety law and aeromedical support. During the field trip a safety survey of an operating squadron is made by the students.

Prior completion of college-level courses in algebra and physics is highly desirable for the prospective student.

Designated naval aviators and naval flight officers of the Navy and Marine Corps in the rank of Lieutenant, (USN) and Captain, (USMC) and above are eligible to attend. Exceptions must be approved by the Director, Aviation Safety Programs. Details of quota control and class schedules are defined in NPSNOTICE 1520.

Resident Students
Officers regularly enrolled in other curricula of the Naval Postgraduate School may qualify for the Aviation Safety Officer Certificate by completing these required courses: AO2020, AO2030, AO3000, AO3010 and AO3040. Substitutions of equivalent courses taken in other departments for some of these courses may be made upon approval of the Director of Aviation Safety Programs. For example, AO2020 may be replaced by upper division or graduate courses in aeronautical engineering which cover the essential subject matter of the course.

AVIATION SAFETY COMMAND COURSE

An Aviation Safety Command (ASC) course is offered eight times each year on a temporary additional duty basis to commanding officers, executive officers, officers in charge of aviation detachments, officers screened for command and staff officers in the rank of Lieutenant Commander, USN, Major, USMC and above. This course is designed to provide information which will assist commanding officers in conducting an aggressive mishap prevention program and to prepare the graduate for the duties of Senior Member of a Mishap Board.

The course consists of approximately 32 classroom and laboratory hours addressing subjects including safety programs, safety psychology, aviation law, aircraft systems, mishap investigation, mishap and incident reports and endorsements and aerospace medicine.

No academic credit is given for this course.

COURSE OFFERINGS

AO2020 AERODYNAMICS FOR AIRCRAFT ACCIDENT PREVENTION AND INVESTIGATION (2-0).
Survey of aerodynamics, performance, stability and control, with emphasis on pre-mishap hazard identification and risk management. Effects of varying designs, configurations, atmospheric conditions, crew techniques and degraded aircraft capabilities on critical areas of operation are discussed and related to current mishap experience. Introduction to current aircraft technology and future design considerations. (Taught in separate rotary-wing and fixed-wing sections).

AO2030 AIRCRAFT STRUCTURAL ANALYSIS (1-0).
Fundamentals of strength of materials, design criteria, and theories of failure. Buckling. Effects of stress concentrations; fatigue process. Identification of static and fatigue fractures. Introduction to composite materials technology.

AO3000 MANAGEMENT OF ACCIDENT PREVENTION PROGRAMS (2-1).
Management theories and practices with emphasis on planning, leading, organizing and controlling. Automatic data-processing systems and analysis of accident statistics. Organizational effectiveness theory and techniques as applied to Navy safety programs. Systems safety theories and techniques applied to hazard detection, analysis, and elimination. Group dynamics and human behavior. Applied theory exercise in hazard detection survey techniques at selected naval aviation organizations.

AO3010 SAFETY INFORMATION MANAGEMENT (2-1).
Techniques of mishap investigation and reporting. Introduction to logic, including deductive and inductive reasoning. Witness interviewing techniques. The legal doctrine of Safety Privilege. Organization and administration of investigative boards and commissions. Through case studies, laboratory and field exercises, the course provides practical experience in investigating and reporting simulated aircraft mishaps.

AO3040 SAFETY PSYCHOLOGY AND PHYSIOLOGY (2-0).
Psychology of high-performance groups; human reliability in survival-value environments; personality elements in safety motivation; risk-taking behavior. The effects of physical and mental/emotional stress on the physiology and performance of aviation personnel. Techniques for identifying and dealing with marginal aviators.

AO3100 MANAGEMENT OF ACCIDENT-PREVENTION PROGRAMS (3-2).
Management theories, practices, communications and controls; automatic data-processing and analysis of accident statistics; legal consideration in safety management; use of systems safety in hazard identification.

AO3120 TECHNOLOGICAL ASPECTS OF ACCIDENT-PREVENTION AND ANALYSIS (3-2).
Topics include case studies of technological design-related aviation mishaps; identification of structural failure modes; computer and simulator methods in aeronautics; safety related problems of Navy weapons systems evaluation and acquisition.

COMMAND, CONTROL & COMMUNICATIONS (C3) ACADEMIC GROUP

Chairman:
Carl R. Jones, Professor
Code CC, Spanagel Hall
Room 203
(408) 656-2618
DSN 878-2618

Dan Calvin Boger, Professor (1979)*; PhD, University of California at Berkeley, 1979.

William J. Caldwell, LtCol, U.S. Army; Instructor (1989); MS, Naval Postgraduate School, 1979.

Michael A. Cervi, Capt., U.S. Air Force; Instructor (1992); MS, Naval Postgraduate School, 1992.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Daniel Roy Dolk, Associate Professor (1982); PhD, University of Arizona, 1982.

Yuen Sun Fu, Joint C3 Chair Professor (1991); PhD, University of Kansas, 1975.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Wayne Philo Hughes, Jr., Adjunct Professor (1979); MS, Naval Postgraduate School, 1964.

Carl Russell Jones, Chairman and Professor (1965); PhD, Claremont Graduate School, 1965.

William G. Kemple, Assistant Professor (1990); PhD, University of California at Riverside, 1989.

Michael Melich, Adjunct Professor (1983); PhD, Rice University, 1967.

Paul H. Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Samuel Howard Parry, Professor (1972); PhD, Ohio State University, 1971.

Gary Kent Poock, Professor (1967); PhD, University of California at Berkeley, 1967.

Nancy Charlotte Roberts, Associate Professor (1986); PhD, Stanford University, 1983.

Michael Graham Sovereign, Professor (1970); PhD, Purdue University, 1965.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Command, Control and Communications (C3) Academic Group is an interdisciplinary association of faculty. An academic group is a less formal organization than an academic department and each professor in the group has an appointment in an academic department. The C3 Academic Group has responsibility for the academic content of the Joint Command, Control and Communications curriculum and a C3 research program. Thesis topics are approved by the group and the final thesis is approved by the Chairman.

MASTER OF SCIENCE IN SYSTEMS TECHNOLOGY

The degree Master of Science in Systems Technology (Command, Control and Communications) will be awarded at the completion of an interdisciplinary program carried out in accordance with the following degree requirements.

The Master of Science in Systems Technology (Command, Control and Communications) requires a minimum of 45 quarter hours of graduate level work in four different academic disciplines, of which at least 15 hours must represent courses at the 4000 level in at least two of the disciplines. Within the course program there must be a specialization sequence consisting of at least three courses.

In addition to the 45 hours of course credit, an acceptable thesis must be completed.

The program must be approved by the Chairman of the Command, Control and Communications Academic Group.

COURSE OFFERINGS

CC0001 SEMINAR (No Credit) (0-1).
Special lectures and discussion of matters related to C3.

CC0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

CC3000 INTRODUCTION TO COMMAND, CONTROL AND COMMUNICATIONS (4-0).
Knowledge of current C3 systems and practice is introduced. A basic framework for understanding C3 is provided. Case studies are used as well as lessons learned from crises, field exercises and wargaming. PREREQUISITES: Enrollment in the Joint C3 curriculum, OS2103 (concurrently).

CC3001 MODELING COMMAND, CONTROL and COMMUNICATIONS SYSTEMS (4-0).
An understanding of C3 modeling in the context of combat models and modeling is provided. The fundamental concepts of combat processes are studied. Specific models of weapons and sensors are included. Examples of current applications and research trends are included. PREREQUISITES: CC3000 and OS2103.

CC3111 C3 MISSION AND ORGANIZATION (4-0).
A survey of command, control and communications organizations within OSD JCS and the Service headquarters. Execution of National Security Nuclear Policy and planning for joint employment of general purpose forces are discussed. Service combat organization and service tactical C3 systems are covered. Emphasis is on description of existing C3 organizations and systems, with brief historical perspective. PREREQUISITE: SECRET clearance.

CC3900 SPECIAL TOPICS IN COMMAND, CONTROL AND COMMUNICATIONS (V-0).
Supervised study in selected areas of command, control and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on Pass/Fail basis only.

CC4001 C3 SYSTEMS ARCHITECTURE & ENGINEERING I (4-2).
Systems engineering concepts and processes. Structural analysis and design techniques. C3 structure and processes dynamics. C3 systems requirements determination. C3 architecture design. C3 architecture cost effectiveness evaluation. Design principles. Includes a C3 architecture design and evaluation project. PREREQUISITES: CC3001, OS3008, OS3604, TOP SECRET with eligibility for SI/SAO. U.S. Citizenship.

CC4002 C3 SYSTEMS ARCHITECTURE & ENGINEERING II (3-3).
Threat analysis. Hardware and software requirements determination. Functional analysis.

Performance analysis. Cost modeling and estimation. Trade-off analysis. Error budget. Risk assessment. Includes a specific C3 systems design and evaluation project. PREREQUISITES: CC4001, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4003 C3 SYSTEMS EVALUATION (2-4).
Experiments in determining C3 system effectiveness using wargaming and simulation. Design of experiments. Survey of current C3 systems evaluation techniques. PREREQUISITES: CC4002, 0S3603, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4004 C3 IN NATO (4-0).
Application of C3 principles to the special problems of NATO. The range of alternatives to improving arms stability in Europe will be explored, including high-tech solutions such as FOFA, low-tech "green" barriers and militia, as well as arms negotiations. C3 planning and evaluation will be covered in application. PREREQUISITES: U.S. Citizenship and SECRET clearance; CC4003 or equivalent.

CC4006 ADVANCED C2 ANALYTICAL CONCEPTS (4-0).
The study of the combat organization's C2 in equilibrium and disequilibrium. The use of Petri Nets in understanding equilibrium is emphasized. The role of catastrophe and chaos theory in understanding disequilibrium is covered. PREREQUISITE: CC4003 or equivalent.

CC4113 POLICIES AND PROBLEMS IN C3 (5-0).
Study of the fundamental role C3 systems fulfill in operational military situations, including crisis warning and crisis management. Analysis of the changing role of intermediate-level headquarters and its impact on C3 system requirements and design. Consideration of the complexities imposed on C3 systems as the force structure becomes more heterogeneous, as in the case of NATO. Case study of selected incidents and systems. Specifically for students in the C3 curriculum. PREREQUISITES: CC4003, TOP SECRET clearance with eligibility for SI/SAO. U.S. Citizenship.

CC4200 COMBAT SYSTEMS ENGINEERING (4-0).
This course examines the generation of combat system requirements and the relationships between operational, financial planning, and technical communities in fielding a combat system that fulfills those requirements. The contribution of the technical disciplines to the statement and solution of decision problems in design, priority setting, and scheduling are explored through the use of currently outstanding issues. PREREQUISITES: Consent of the Instructor, basic probability and statistics, fourth quarter standing and SECRET clearance. Graded on a Pass/Fail basis only.

CC4900 ADVANCED STUDY IN COMMAND, CONTROL AND COMMUNICATIONS (V-0).
Supervised study in selected areas of command, control and communications to meet the needs of individual students. May be repeated for credit if course content changes. PREREQUISITE: Consent of Group Chairman. Graded on a Pass/Fail basis only.

DEPARTMENT OF COMPUTER SCIENCE

Chairman:
Robert B. McGhee,
Professor
Code CS, Spanagel Hall
Room 513
(408) 656-2449
DSN 878-2449

Associate Chairmen:

Instruction
Man-Tak Shing
Associate Professor
Code CS/Sh, Spanagel Hall
Room 544B
(408) 656-2634
DSN 878-2634

Research
Valdis Berzins
Associate Professor
Code CS/Be, Spanagel Hall
Room 528A
(408) 656-2461
DSN 878-2461

Academic Affairs
Uno R. Kodres
Professor
Code CS/Kr, Spanagel Hall
Room 534A
(408) 656-2197
DSN 878-2197

Administrative Affairs
Michael J. Zyda
Associate Professor
Code CS/Zk, Spanagel Hall
Room 516
(408) 656-2305
DSN 878-2305

Charles Altizer, LT, U.S. Navy; Instructor (1991)*; MS, Naval Postgraduate School, 1988.

Hemant K. Bhargava, Assistant Professor (1989); PhD, University of Pennsylvania, 1989.

Leigh W. Bradbury, LCDR, U.S. Navy; Instructor (1988); MS, Corpus Christi State University, 1985.

John Daley, LCDR, USN, Instructor (1992); MS, Naval Postgraduate School, 1992.

David A. Erickson, Adjunct Instructor (1988); PhD, Stanford University, 1991.

John Falby, Lieutenant Commander, U.S. Navy; Instructor (1991); MS, Naval Postgraduate School, 1986.

Richard W. Hamming, Adjunct Professor (1976); PhD, University of Illinois, 1942.

David K. Hsiao, Professor (1982); PhD, University of Pennsylvania, 1968.

Gary Hughes, CDR, U.S. Navy; Instructor (1986); MS, Naval Postgraduate School, 1983.

Yutaka Kanayama, Professor (1990); PhD, Tokyo University, 1965.

Uno R. Kodres, Professor (1963); PhD, Iowa State University, 1958.

Se-Hung Kwak, Adjunct Professor (1987); PhD, Ohio State University, 1986.

Yuh-jeng Lee, Assistant Professor (1987); PhD, University of Illinois at Urbana, 1987.

LuQi, Associate Professor (1986); PhD, University of Minnesota, 1986.

Vincent Y. Lum, Professor (1985); PhD, University of Illinois at Urbana, 1966.

G.M. Lundy, Assistant Professor (1988); PhD, Georgia Institute of Technology, 1988.

Robert B. McGhee, Chairman and Professor (1986); PhD, University of Southern California, 1963.

Michael L. Nelson, Maj, U.S. Air Force; Assistant Professor (1989); PhD, University of Central Florida, Orlando, 1988.

David R. Pratt, Adjunct Instructor (1990); MS, Naval Postgraduate School, 1988.

Neil C. Rowe, Associate Professor (1983); PhD, Stanford University, 1983.

Timothy J. Shimeall, Assistant Professor (1988); PhD, University of California at Irvine 1989.

Man-Tak Shing, Associate Professor (1988); PhD, University of California at San Diego, 1981.

Roger Stemp, Adjunct Research Assistant (1991); MS, Naval Postgraduate School, 1983.

Louis D. Stevens, Adjunct Professor (1984); MS, University of California at Berkeley, 1949.

Dennis M. Volpano, Assistant Professor (1991); PhD, Oregon Graduate Istitute, 1986.

Lawrence J. Williamson, Adjunct Professor (1989); PhD, University of California at Berkeley, 1973.

C. Thomas Wu, Associate Professor (1985); PhD, University of California at San Diego, 1983.

Amr M. Zaky, Assistant Professor (1989); PhD, Ohio State University, 1989.

Michael J. Zyda, Associate Professor (1984); DSc, Washington University, 1984.

* The year of joining the Naval Postgraduate School faculty is indicated in parenthesis.

The Department of Computer Science provides graduate training and education in major areas of computer science. Thus, both basic and advanced graduate courses are offered. Course work and research lead to either the degree of Master of Science or Doctor of Philosophy. The requirements to complete either program are rigorous and are comparable to those of other major universities.

MASTER OF SCIENCE IN COMPUTER SCIENCE

The degree Master of Science in Computer Science is awarded upon the satisfactory completion of a program, approved by the Chairman, Computer Science Department, which satisfies, as a minimum, the following degree requirements:

a. At least 40 quarter hours of graduate-level work of which at least 12-quarter hours must be at the 4000 level.

b. Completion of an approved sequence of courses constituting specialization in an area of Computer Science.

c. Completion of an acceptable thesis in addition to the 40-quarter hours of course work.

DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE

The Department of Computer Science has a program leading to the degree Doctor of Philosophy. Areas of special strength in the department are artificial intelligence/robotics, computer graphics & visual simulation, software engineering, database & data engineering, and computer systems & architectures. A noteworthy feature is that the candidate's research may be conducted off-campus in the candidate's sponsoring laboratory or unit of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

COMPUTER SCIENCE LABORATORIES

Laboratory Overview

The departmental laboratories are designed to provide effective computing facilities to

support instruction and research in the core areas of computer science. There are currently seven such laboratories: the Computer Science Academic Computing Laboratory, the Artificial Intelligence and Robotic Laboratory, the Computer Systems and Security Laboratory, the Graphics and Video Laboratory, the Microcomputer Systems Laboratory, the Software Engineering Laboratory and the Visual Database and Interface Laboratory. These laboratories are configured in a complex network system with remote file system access and resource sharing facilities. The network system consists of a departmental backbone network interconnecting to the subnets of the individual laboratories which, in turn, are connected to lower level subnets of a client-server variety. In addition to providing local connectivities, the backbone network also provides a gateway to the Internet.

Computer Science Academic Laboratory
The main pieces of equipment in the Computer Science Academic Laboratory are nine Sun servers with over 100 client workstations. Approximately half of the client workstations are located within the laboratory for student access while the remaining client workstations are distributed to individual faculty and staff offices. Each server is equipped with large memory and disk capacity with modem and terminal support for remote access. The laboratory provides a general purpose, time-sharing environment for a variety of programming languages and software tools.

Computer Systems and Security Laboratory
The Computer Systems and Security Laboratory has three distinct sub-laboratories: the Database Systems Lab, the Multimedia DBMS lab and security lab. The Database System Lab has a focus on multi-backend database machines. The multimedia DBMS lab has a focus on utilizing low-cost workstations and PC technology for the intelligent storage and retrieval of multimedia data. The computer security has a focus on a secure heterogeneous, distributed computing environment.

Graphics and Video Laboratory
The Graphics and Video Laboratory consists of several Silicon Graphics, Inc. IRIS workstations. These workstations are used to provide instructional support for the Computer Graphics & Visual Simulation track of the Department of Computer Science and to provide research support for efforts in virtual world and visual simulation system construction. The highest performance workstations currently in the laboratory are capable of filling some one million polygons per second. The laboratory is equipped with a variety of video and multimedia support hardware. Research efforts of the laboratory currently revolve around the NPSNET system, a low-cost, workstation-based, 3D visual simulator that utilizes SIMNET databases and networking formats. Sponsors of the research in the laboratory include DARPA/ASTO, USA HQDA AI Center, USA Topographic Engineering Center, USA Test and Experimentation Command, USA STRICOM, USA TRADOC Analysis Command, the Naval Ocean Systems Center, and the Naval Postgraduate School's Direct Funding Program.

Software Engineering Laboratory
The current Software Engineering Laboratory consists of several large Sun fileserver and diskless node workstations. The workstations are Unix-based, general purpose workstations and are equipped with the ADA programming language and a variety of software engineering tools. The purpose of this laboratory is to provide a state-of-the-art educational environment for graphics-based software development automation. Current work in the laboratory is on rapid prototyping, specification languages and computer-aided software system design, software verification and testing, software safety and computer-aided instruction. The ongoing projects are sponsored by ONR, CNO, ONT, NOSC, NAVSEA, NSWC, RADC and NSF.

Microcomputer Laboratory
The current Microcomputer Systems Laboratory consists of some 486 PC microcomputers in support of research and instruction. The main use of the PCs microcomputers is for instruction in beginning programming with the Department of Defense's standard computer language Ada. The PCs are also used for research and instruction in microprocessor programming, microprocessor architectures, networking and distributed

systems. The PCs are networked to provide access to shared resources such as printers. The laboratory also supports ongoing research on transputer applications to real-time embedded military systems.

Visual Database and Interface Laboratory
The current Visual Database and Interface Laboratory consists of Macintosh II and IBM PC/AT compatible microcomputers. The main use of the laboratory is research and instruction in human-computer interfaces for data retrieval systems. The main projects in the laboratory are a paperless ship project (ARGOS) sponsored by NAVSEA and a visual query language for databases project sponsored by the Naval Weapons Station, Concord.

Artificial Intelligence Laboratory
The Artificial Intelligence Laboratory consists of one IRIS graphics workstation, eight Sun diskless workstations and four TI Explorer LISP machines. The Sun workstations are Unix-based, general purpose workstations. They are outfitted with LISP, Prolog and various knowledge-based software tools. The IRIS workstation is a base system of the Autonomous Mobile Robot "Yamabico-11" with an image-grabbing capability for a color TV camera. This laboratory also supports the research on planning, navigation, dynamics and control of Autonomous Underwater Vehicles sponsored by NAVSEA.

COURSE OFFERINGS

CS0001 COLLOQUIUM (NO CREDIT) (0-1).
Distinguished lecturer series. Attendance is required by students in their third through sixth quarters.

CS0100 REFRESHER FOR BEGINNING PROGRAMMING (NO CREDIT) (2-1).
Meets last six weeks of the quarter. An introduction to computer algorithms, programs and hardware. Using structured programming and stepwise refinement techniques, students receive classroom instruction plus design and test programs in the laboratory. Computer projects of increasing difficulty are assigned. This course is not graded.

CS0101 REFRESHER FOR LABORATORY SYSTEMS (NO CREDIT) (2-1).
Meets last six weeks of the quarter. Intended for computer science majors, to provide an introduction to Computer Science Department laboratory facilities. Both Unix and the MS-DOS operating systems are introduced from a user perspective, as well as operation of corresponding workstation and personal computer hardware. Each system's user interface, text processing, programming environment, network and communication facilities are surveyed. Students are exposed to basic principles and procedures for productive software and document development through both lecture and hands-on tutorials. Should be taken concurrently with CS0100. This course is not graded.

CS0102 REVIEW FOR DIRECT INPUT STUDENTS (NO CREDIT) (2-1).
An individualized course to cover the topics of CS0100 and CS0101. The course is open only to first quarter computer science majors who did not take CS0100 and CS0101. This course is not graded.

CS0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

CS2450 COMPUTER PROGRAMMING WITH FORTRAN (3-1).
This course provides an overview of the computer system: hardware, software and the operating system. Algorithms and programs are developed using a structured approach and stepwise refinement. The design and testing of computer programs in FORTRAN are studied and practiced by the student in the laboratory. Computer projects of increasing difficulty are assigned. Graded on Pass/Fail basis only.

CS2920 INTRODUCTORY TOPICS IN COMPUTER SCIENCE (Hours vary 2-4 to 4-1) (V-V).
Designed to support introductory subject matter of special interest, dependent upon faculty availability. Topics will typically augment those offered in the basic core courses. This course may be lecture/lab oriented or self-paced, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic.

CS2970 STRUCTURED PROGRAMMING WITH ADA (4-1).
An introduction to problem solving and structured programming with Ada, a high-level, block-structured programming language. This course is for computer science majors and other students with a deep interest in the subject. Fundamental techniques of problem solving and using Ada to implement the solutions of non-numerical problems are presented. Several programming projects aimed at practicing these techniques are assigned during the course.

CS3010 COMPUTER SYSTEMS PRINCIPLES (4-0).
Designed to provide computer science majors with a basic understanding of computer systems hardware. The course includes the following topics: basic computer concepts, number systems and data representation, digital logic and Boolean algebra, storage devices and organization, basic computer organization and control, and instruction formats, addressing modes and the assembler process. No previous background in computer hardware is assumed.

CS3030 COMPUTER ARCHITECTURE AND OPERATING SYSTEMS (4-0).
This course, designed for non-computer science majors, provides an overview of basic computer hardware concepts and operating systems software. The following topics are covered: basic computer concepts; data representation; elements of computer architecture and operation; processor and process management; multiprogramming; memory management; and file management. Future trends in computer hardware and operating systems will be discussed. PREREQUISITE: CS2970 or consent of instructor.

CS3050 SOFTWARE DEVELOPMENT FOR COMBAT SYSTEMS (3-2).
This course covers the unique characteristics of software development for mission-critical embedded computer systems. Students will be introduced to real-time systems issues including analysis, design, process scheduling, operating systems, communications, architecture and fault-tolerance. The DoD Standard 2167A life cycle model will be explored along with analysis, design, programming, and verification methodologies used in developing combat systems software. Students will learn the Ada programming language's real-time tasking and inter-process communication techniques and be introduced to tools for prototyping, code reuse, and automatic code generation and documentation. The laboratory experience includes work with software analysis, design, and programming tools to build a combat-type software system from requirements analysis through verification. PREREQUISITE: CS2970 or Ada programming experience.

CS3111 PRINCIPLES OF PROGRAMMING LANGUAGES (4-0).
An introduction to the design, evaluation and implementation of programming languages. The four themes of name, data, control and syntactic structuring are traced through the five major programming language generations. Principles for the evaluation of languages are developed and investigated. Key implementation concepts are covered, including interpreters and runtime organization. PREREQUISITE: CS2450 or CS2970, or consent of instructor.

CS3113 INTRODUCTION TO COMPILER WRITING (3-2).
This course in intended to explore the basics of modern compiler design and construction techniques. The fundamentals of scanning, parsing, and compiler semantics are developed in the framework of modern compiler-compiler and translator-writing systems technology. The laboratory periods will be used to develop a small model compiler/assembler. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS3200 COMPUTER ARCHITECTURE (3-2). This course examines the organization of computer and processor architectures. Instruction set design alternatives, processor implementation, memory system hierarchy, and I/O systems are the main topics of study. A quantitative approach is taken in which different design alternatives are evaluated and compared through analysis and/or experimentation. The course is accompanied by a set of labs which reinforce and extend the lecture subject matter.

CS3300 DATA STRUCTURES (3-1).
The purpose of this course is to introduce modern techniques for the design, analysis, and implementation of data structures. This includes: theoretical material (time and space analysis, abstract data types); current practice (applications to memory management, compiler design; sorting/searching algorithms); programming techniques (information hiding, packages, programming from specifications, testing); programming practice (non-trivial assignments which emphasize pinters, file I/O, recursion, advanced features of Ada (exceptions and generics), and teamwork.

CS3310 ARTIFICIAL INTELLIGENCE (4-0).
Survey of topics and methods of Artificial Intelligence. Methods include rule-based systems, heuristic search and exploitation of natural constraints, means-ends analysis, semantic networks and frames. Emphasis is placed on solving problems that seem to require intelligence rather than attempting to simulate or study natural intelligence. Projects to illustrate basic concepts are assigned. PREREQUISITE: MA0125 or MA2025 or consent of instructor.

CS3320 DATABASE SYSTEMS (3-1).
This course presents an up-to-date introduction to database systems including database system architectures, data models, querry languages, design of databases. PREREQUISITES: CS3300 or consent of instructor.

CS3450 SOFTWARE SYSTEM DESIGN (3-1).
The course covers the design and implementation of system software elements, including assemblers, loaders, macro-processors, input/output control sub-systems and interpreters, interrupt handlers, memory managers, and process schedulers. PREREQUISITES: CS3200 and CS3300.

CS3460 SOFTWARE METHODOLOGY (3-1).
Introduction to the software life cycle. Methods for requirements definition, design and testing of software. Basic concepts of software engineering, including stepwise refinement, decomposition, information hiding, debugging and testing. PREREQUISITES: CS3111 and CS3300.

CS3502 COMPUTER COMMUNICATIONS AND NETWORKS (4-0).
An introduction to the structure and architecture of computer networks. The physical, data link and network layers of the ISO model are covered, as well as some aspects of the higher layers. Several important communication protocols are studied, including the currently used models for their specifications and analysis. Local Area Networks, such as Ethernet and Token Ring, are also covered. Term papers and/or projects are an important aspect of this course. PREREQUISITE: CS3200 or CS3010 and a basic course in probability.

CS3550 COMPUTERS IN COMBAT SYSTEMS (3-2).
This course describes the functions and the algorithms of combat systems human interaction and systems organization in terms of processes. The laboratory component of the course allows student hands-on experience with the algorithms and input/output devices. Included are navigational tracking and ballistic functions, display control and the use of advance and await/primitives in process control. PREREQUISITE: CS2970 and CS3200 or equivalent.

CS3601 THEORY OF FORMAL LANGUAGES AND AUTOMATA (4-0).
This course will cover the Chomsky hierarchy of formal languages (regular sets, context-free languages, context-sensitive languages and recursively enumerable languages) and the types of grammars and automata associated with each class in the hierarchy. Emphasis is placed on the major results of the theory as they relate to language and compiler design. In addition, the major results involving the concept of undecidability are covered. PREREQUISITES: MA2025 and MA3026 or equivalent.

CS3650 DESIGN AND ANALYSIS OF ALGORITHMS (4-0).
This course focuses on the design and analysis of efficient algorithms. Techniques for analyzing algorithms in order to measure their efficiency are presented. Control structure

abstractions, such as divide and conquer, greedy, dynamic programming, backtrack (branch and bound) and local search methods are studied. The theory of NP-completeness is presented along with current approaches to NP-hard problems. PREREQUISITE: CS3300 or equivalent.

CS3700 ADVANCED PROGRAMMING IN C++ (3-2).
This course covers the design and implementation of computer programs in the programming language C++. The implementation part of the course is on programming including types, operators, structures, control, and functions. The design part of the course is on object-oriented programming, encapsulation (classes and objects), inheritance (class hierarchies), polymorphism, templates, toolkits, and reusable class libraries. PREREQUISITES: CS2970 (Structured Programming with Ada) and CS3300 (Data Structures) or the consent of the instructor.

CS3800 DIRECTED STUDY IN COMPUTER SCIENCES (Variable hours 0-2 to 0-8). (0-V).
Individual research and study by the student under the supervision of a member of the faculty. The course is intended primarily to permit interested students to pursue in-depth subjects not fully covered in formal class work. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS3920 TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1). (V-V).
Designed to support subject matter of special interest, dependent upon faculty availability. Topics will either be drawn from areas not covered by core courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. PREREQUISITE: Consent of instructor.

CS4112 OPERATING SYSTEMS (4-0).
An in-depth theoretical treatment of operating systems concepts. Major course topics include process synchronization using semaphores, critical regions and rendezvous, virtual memory including demand paging and segmentation, dynamic linking and loading, file structures and information security. The producer-consumer problem, readers and writers problem and the dining philosophers problem are examined. Architectural and language implications of evolving operating systems are considered. PREREQUISITE: CS3450 or consent of the instructor.

CS4113 ADVANCED LANGUAGE TOPICS (4-0).
This course is designed to explore concepts considered essential to the study of programming languages. These concepts include the lambda calculus, the Church-Rosser Theorem, reduction strategies, continuations, semantics, and recursion. PREREQUISITES: CS3111 and CS3450, or consent of instructor.

CS4114 ADVANCED TOPICS IN OBJECT-ORIENTED PROGRAMMING (3-2).
This course covers the area of object-oriented programming (OOP) in detail. Investigating current OOP research will be the mainstay of the class. Typical topics will include data abstracation, inheritance, encapsulation, delegation, object-oriented databases and concurrency. Object-oriented languages and applications will also be discussed. A significant programming project is also required. PREREQUISITE: CS4311 or consent of instructor.

CS4150 PROGRAMMING TOOLS AND ENVIRONMENTS (4-0).
The design and implementation of tools to aid software development are the topics of this course, including syntax-directed editors, version-control systems, language-oriented debuggers, symbolic execution vehicles, programming databases, macroprocessors and automatic programming tools. These topics are discussed in the context of an integrated, programming environment. PREREQUISITE: CS3450 or consent of the instructor.

CS4202 COMPUTER GRAPHICS (3-2).
An introduction to the principles of the hardware and software used in the production of computer generated images. The focus of the course is a major design project utilizing the departmental computer graphics and image processing facilities. The course is intended for

students proficient in the development of software systems. (No excuses will be accepted!) PREREQUISITES: CS2970, CS3300, CS3700 or consent of the instructor.

CS4203 INTERACTIVE COMPUTATION SYSTEMS (3-2).
The principles of human computer interfaces and their implementation techniques. Several different interfaces are covered with an emphasis on the direct manipulation interface. The principles discussed will be illustrated with several commercial software systems. The main focus is a design project of building a simple application software system that supports human-computer interface principles. PREREQUISITES: CS3111 and CS3300 or consent of instructor.

CS4310 ADVANCED ARTIFICIAL INTELLIGENCE (4-0).
Artificial Intelligence has seen a rapid growth in applications in recent years. This course will survey key areas of current research. Areas surveyed include language understanding, computer vision, planning human tutoring, qualitative reasoning and automated reasoning. PREREQUISITE: CS3310.

CS4311 EXPERT SYSTEMS (3-1).
Fundamental issues in expert system design and construction. Topics include: knowledge representation schemes and reasoning methods, uncertainty management, truth maintenance trade-off of search versus knowledge by computer induction, real-time knowledge-based systems, system building tools and shells and validation and measurements methods. Several projects related to these topics will be assigned throughout the course. In addition, each student will be required to complete a term project. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4312 ADVANCED DATABASE SYSTEMS (3-1).
Sequel to CS3320, Database Systems. The course will provide an in-depth coverage of relational database theory, distributed database systems, semantic data models, query processing and optimization, logic and databases and other advanced topics. Many topics will be illustrated using both commercial and prototype database systems. PREREQUISITE: CS3320 or consent of instructor.

CS4313 ADVANCED ROBOTIC SYSTEMS (4-0).
Fundamental concepts and theories in autonomous robotics. Especially, theories and techniques in motion planning, motion design, vehicle kinematics, sensing, guidance, learning, environmental representation, and control architectures for autonomous mobile vehicles. The autonomous mobile robot Yamabico-11 will be used for hands-on experiments. We will also discuss several existing significant robotic research projects and control architectures in the U.S. and other countries. PREREQUISITE: CS3310 or consent of instructor.

CS4314 SYMBOLIC COMPUTING (3-2).
This course is concerned with symbolic computing, that is, using computers to manipulate symbols. The first part of the course will focus on the fundamentals of Lisp programming including list processing, function definition, recursion, data structures, Common Lisp Object System (CLOS) and Lisp I/O. The second part of the course will emphasize the use of Lisp to support different Artificial Intelligence applications: search techniques, neural networks, genetic algorithms, etc. Students are required to complete several homework exercises and a term project. Enrollment will be limited to ensure adequate student involvement in class presentations. PREREQUISITE: CS3310 (or equivalent) or consent of instructor.

CS4322 ADVANCED DATABASE SYSTEMS SEMINAR (3-1).
This course covers the advanced and current research on database topics that have not been discussed fully in the prior database courses CS3320 and CS4312. Possible topics to be discussed in the course include database machines (especially multi-lingual and multi-backend systems), multimedia DBMS, semantic modeling, DB security, knowledge-based DBMS, non-normalized relations, temporal information handling, advanced data structures, real-time database systems, etc. The studies may be theoretical, pragmatic and

analytical, or experimental using some advanced prototype database systems. PREREQUISITE: CS4300 or CS4312, or consent of instructor.

CS4450 COMPUTER ARCHITECTURE (4-0).
Advanced topics in computer architecture and the application of concepts in computer architecture to the design and use of computers. The topics discussed include classes of computer architecture, application-oriented architecture and high-performance architecture. PREREQUISITE: CS3200 or equivalent.

CS4451 DESIGN AND ANALYSIS OF MULTIPLE-PROCESSOR, REAL-TIME COMPUTERS (3-1).
Computer architectures ranging from single instruction stream to multiple data stream architectures. Processing capacities of vector processors, array processors, multiprocessors and massively parallel processors are compared to each other in various real time applications. Parallel processing software issues ranging from parallel processing languages to operating systems support issues are considered. Reliability, availability and survivability of systems are also considered. PREREQUISITES: CS3200 and CS3450 or consent of instructor.

CS4470 ADVANCED COMPUTER GRAPHICS TOPICS (3-2).
This course covers advanced topics in computer image generation. The topics discussed include quality and realism in computer images, advanced realtime interactive systems and special architectures for the real-time generation and display of computer images. PREREQUISITES: CS4202 and consent of instructor.

CS4471 COMPUTER ANIMATION (3-2).
This course has the goal of presenting state-of-the-art animating 3D computer models. Topics covered include computational techniques for real-time animation, motion control systems, interactive keyframe systems, motion simulation, event driven animations, kinematic methods for figure animation, dynamics for figure animation, task-level animations and other high-level approaches to animation. PREREQUISITE: CS4202 or the consent of the instructor.

CS4472 PHYSICALLY-BASED MODELING (3-2).
A physically-based model is a mathematical representation of an object (or its behavior) which incorporates forces, torques, energies and other attributes of Newtonian physics. The goal of this course is to use such modeling to simulate, and graphically depict, the realistic behavior of flexible and rigid 3D objects. Topics covered in the course include teleological modeling, kinematic constraints, behavior functions, inverse dynamics, collision detection, distributed behavioral models, flexible bodies, energy constraints and physically-based rendering. PREREQUISITES: CS4470 (Image Synthesis) and CS4471 (Computer Animation) or the consent of the instructor.

CS4473 VIRTUAL WORLDS AND SIMULATION SYSTEMS (3-2).
The design and implementation of real-time, visual simulation systems for animating and interacting with virtual environments. The course pays special attention to practical issues involving performance/realism tradeoffs; experience with computer/human interaction, especially novel input devices and pardigms; and simulating kinematic and dynamic behaviors in real-time. PREREQUISITES: CS4471 (Computer Animation) and corequisite CS4472 (Physically-Based Modeling) or the consent of the instructor.

CS4500 SOFTWARE ENGINEERING (3-1).
The techniques for the specification, design, testing, maintenance and management of large software systems. Specific topics include software life cycle planning, cost estimation, requirements definition and specification, design, testing and verification, maintenance and reusability. The laboratory sessions will discuss special topics. PREREQUISITE: CS3460 or consent of instructor.

CS4520 ADVANCED SOFTWARE ENGINEERING (3-0).
This course is a sequel to CS4500. The methods for specifying, designing and verifying software systems are covered in-depth, with emphasis on automatable techniques and

their mathematical basis. The techniques are applied to construct and check Ada programs using a formal specification language. The course concludes with a summary of current research areas in software engineering. PREREQUISITE: CS4500 or consent of instructor.

CS4530 SOFTWARE ENGINEERING IN ADA (3-0).
This course is a sequel to CS4500. The study of software engineering in Ada represents a tremendous opportunity for improvement in the clarity, reliability, efficiency and maintainability of software systems. Special features of designing large, real-time, embedded computer systems, automated tools in the Ada environment and many applications of the principles in software engineering will be illustrated through the systematic study of the Ada language. PREREQUISITE: CS4500 or consent of the instructor.

CS4540 SOFTWARE TESTING (3-1).
This course covers the theory and practice of testing computer software with the intent of preventing, finding and eliminating bugs in software. Planning and executing software tests are covered, including requirements-based testing, functional testing, static analysis, code reading, symbolic testing, structural testing, and advanced testing techniques. These topics are dicussed in the context of a realistic development environment, illustrated using a variety of software testing tools. PREREQUISITE: CS4500 or consent of instructor.

CS4550 COMPUTER NETWORKS II (4-0).
A continuation of CS3502. The course study emphasizes metropolitan area networks and wide area networks, including the recently developed optical fiber network standards. Integrated networks and ISDN/BISDN are covered. The public telephone network and its relationship to computer networks. Applications of high speed networks and potential future developments. PREREQUISITE: CS3502.

CS4601 COMPUTER SECURITY (4-0).
This course is concerned with fundamental principles of computer security. It covers privacy concerns, secrecy issues, operational security, physical security, hardware security, software security, communications security and data security. There is a special emphasis on multilevel security and access control in computer systems. PREREQUISITES: For CS majors, CS3200, CS3320, CS3450, CS3460 and CS3502; for CSM majors, CS3010, CS3020, CS3030, CS3220 and IS3502.

CS4602 ADVANCED COMPUTER SECURITY (4-0).
This course focuses on applied computer security technology developed over the last fifteen to twenty years. Specific topics include a review of finite state machines, finite state security models, implementation of multilevel security mechanisms, architectural considerations, formal specification and verification, multilevel databases, networks and distributed systems in a multilevel environment. The course will also take an in depth look at recent advances in encryption services, integration of encryption into packet protocols and key mangement. The basic text for the course will be augmented by several papers dealing with recent research in various technical areas. In adition to several homework assignments, each student will be required to do a major paper or project. PREREQUISITE: CS4601

CS4800 DIRECTED STUDY IN ADVANCED COMPUTER SCIENCE (Variable hours 0-2 to 0-8) (0-V).
Directed advanced study in computer science on a subject of mutual interest to student and faculty member. Intended primarily to permit students to pursue in-depth subjects not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

CS4900 RESEARCH SEMINAR IN COMPUTER SCIENCE (0-2).
An examination of the current and planned research of Computer Science faculty and PhD students in multiple fields of study. The course is designed to support Computer Science students in their fourth quarter of study in the selection of an area/topic for thesis research. PREREQUISITE: Computer Science students in fourth quarter or consent of department Chairman. Graded on Pass/Fail basis only.

CS4901 RESEARCH SEMINAR IN COMPUTER SCIENCE II (2-0).
This course develops skills in software description necessary for successful completion of a MS thesis. Students who can already demonstrate excellent writing skills will be able to validate this course. PREREQUISITE: CS4900 or consent of instructor.

CS4910 ADVANCED READINGS IN COMPUTER SCIENCE (Variable hours 0-2 to 0-8) (0-V).
Directed readings in computer science on a subject of mutual interest to student and faculty member. The course allows in-depth study of advanced topics not fully covered in formal class work or thesis research. May be repeated for credit with a different topic. PREREQUISITE: Consent of instructor.

CS4920 ADVANCED TOPICS IN COMPUTER SCIENCE (Variable hours 2-4 to 4-1) (V-V).
Designed to support advanced subject matter of special interest, dependent upon faculty availability. Topics will be drawn from areas not covered by other advanced courses, or be focused treatments of subjects of limited scope. This course may be lecture or lab oriented, with prerequisites determined by the instructor. Students may repeat this course for credit with a different topic. PREREQUISITE: Consent of instructor.

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Chairman:
Michael A. Morgan
Professor
Code EC, Spanagel Hall
Room 437
(408) 656-2081
DSN 878-2081

Associate Chairmen:

Instruction
Charles W. Therrien
Professor
Code EC/Ti, Spanagel Hall
Room 458
(408) 656-3347
DSN 878-3347

Student Programs
R. Clark Robertson
Associate Professor
Code EC/Rc, Spanagel Hall
Room 414A
(408) 656-2383
DSN 878-2383

Research
Herschel H. Loomis, Jr.
Professor
Code EC/Lm, Spanagel Hall
Room 446
(408) 656-3214
DSN 878-3214

Richard W. Adler, Adjunct Professor (1970)*; PhD, Pennsylvania State University, 1970.

Robert W. Ashton, Assistant Professor (1992); PhD, Worchester Polytechnic Institute, 1991.

Raymond Bernstein, Adjunct Instructor (1989); MS, Naval Postgraduate School, 1982.

Jeffrey B. Burl, Associate Professor (1987); PhD, University of California at Irvine, 1987.

Jon T. Butler, Professor (1987); PhD, Ohio State University, 1973.

Roberto Cristi, Associate Professor (1985); PhD, University of Massachusetts, 1983.

Monique P. Farques, Assistant Professor (1989); PhD, Virginia Polytechnic Institute and State University, 1988.

Douglas J. Fouts, Assistant Professor (1990); PhD, University of California at Santa Barbara, 1990.

Gurnam S. Gill, Adjunct Professor (1990); PhD, Southern Methodist University, 1981.

Tri T. Ha, Professor (1987); PhD, University of Maryland, 1977.

Ralph Hippenstiel, Associate Professor (1986); PhD, New Mexico State University, 1985.

Ramakrishna Janaswamy, Associate Professor (1987); PhD, University of Massachusetts, 1986.

David C. Jenn, Associate Professor (1990); PhD, University of Southern California, 1989.

Jeffrey B. Knorr, Professor (1970); PhD, Cornell University, 1970.

Frank E. Kragh, LT, U.S. Navy; Instructor (1990); MSEE, University of Central Florida, 1990.

Allan Kraus, Adjunct Professor (1976); PhD, University of South Florida, 1976.

Alex W. Lam, Assistant Professor (1990); PhD, University of Illinois, 1987.

Chin-Hwa Lee, Professor (1982); PhD, University of California at Santa Barbara, 1975.

Hung-Mou Lee, Associate Professor (1982); PhD, Harvard University, 1981.

Frederic H. Levien, Adjunct Professor (1990); MS, Lehigh University, 1967.

Herschel H. Loomis, Jr., Professor (1981); PhD, Massachusetts Institute of Technology, 1963.

Sherif Michael, Associate Professor (1983); PhD, University of West Virginia, 1983.

James H. Miller, Associate Professor (1987); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1987.

Paul H. Moose, Associate Professor (1980); PhD, University of Washington, 1970.

Michael A. Morgan, Professor (1979); PhD, University of California at Berkeley, 1976.

Glen A. Myers, Associate Professor (1965); PhD, Stanford University, 1965.

Phillip E. Pace, Assistant Professor (1992); PhD, University of Cincinnati, 1990.

Rudolph Panholzer, Professor (1964); DSc, Technische Hochschule in Graz, Austria, 1961.

Ron J. Pieper, Associate Professor (1990); PhD, University of Iowa, 1984.

John P. Powers, Professor (1970); PhD, University of California at Santa Barbara, 1970.

R. Clark Robertson, Associate Professor (1989); PhD, University of Texas at Austin, 1983.

Michael Shields, LCDR, U.S. Navy; Assistant Professor (1992); PhD, Naval Postgraduate School, 1991.

Shridhar, B. Shukla, Assistant Professor (1990); PhD, North Carolina State University, 1989.

Greg Skinner, LCDR, U.S. Navy; Instructor (1991); MSEE, Naval Postgraduate School, 1987.

Robert D. Strum, Professor Emeritus (1958); MS, University of Santa Clara, 1964.

Frederick Terman, Adjunct Professor (1983); MSEE, Stanford University, 1964.

George J. Thaler, Professor Emeritus (1951); DEng, Johns Hopkins University, 1947.

Charles W. Therrien, Professor (1984); PhD, Massachusetts Institute of Technology, 1969.

Harold A. Titus, Professor (1962); PhD, Stanford University, 1962.

Murali Tummala, Associate Professor (1987); PhD, India Institute of Technology, 1984.

Donald van Z. Wadsworth, Adjunct Professor (1988); PhD, Massachusetts Institute of Technology, 1958.

Stephen M. Williams, Assistant Professor (1990); PhD, University of Missouri-Columbia, 1989.

Chyan Yang, Assistant Professor (1987); PhD, University of Washington, 1987.

Lawrence J. Ziomek, Associate Professor (1982); PhD, Pennsylvania State University, 1981.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Electrical and Computer Engineering is the major contributor to programs for the education of officers in the Electronic Systems Engineering curriculum and the Space Systems Engineering curriculum. Additionally, the department offers courses in support of other curricula such as Electronic Warfare Systems Technology, Information Technology Management, Command, Control and Communications, Space Systems Operations, Weapons Systems Engineering, Underwater Acoustics and Engineering Acoustics.

The department offers programs leading to the Master of Science degree in Electrical Engineering (MSEE), the degree of Electrical Engineer (EE) and Doctor of Philosophy (Ph.D.). The department typically graduates over 100 MSEE degree candidates, five EE degree recipients and one Ph.D. per year.

An MSEE student will usually spend six to twelve months learning or reviewing material at a junior or senior level before entering into graduate studies. The graduate study portion of a typical program is about one year in duration with a combination of course study and thesis work being performed. The thesis portion of the study is the equivalent of four courses with an acceptable written thesis being a requirement for graduation.

The curriculum is organized to provide the students with coursework spanning the breadth of Electrical and Computer Engineering. Students are required to take at least one graduate-level course in random processes, applications of random processes and mathematics. In addition to these requirements, students concentrate in one major area of Electrical and Computer Engineering by taking a planned sequence of advanced courses. Currently there are formal concentrations in:

Communications Systems
Computer Systems
Guidance, Navigation and Control Systems
Electromagnetic Systems
Power Systems
Signal Processing Systems

The program leading to the MSEE is accredited as an Electrical Engineering Program at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

The department has about fifty faculty members either on a permanent or visiting basis contributing to the instructional and research programs.

MASTER OF SCIENCE IN ELECTRICAL ENGINEERING
A Bachelor of Science in Electrical Engineering or its equivalent is required. Credits earned at the Naval Postgraduate School and credits from the validation of appropriate courses at other institutions are combined to achieve the degree equivalence.

To complete the course requirements for the master's degree, a student needs a minimum of 36 credits in the course sequence 3000 - 4999 of which at least 27 credits must be in Electrical and Computer Engineering. Specific courses may be required by the department and at least four courses that total a minimum of 12 credits, must be in the course sequence 4000 - 4999.

An acceptable thesis must be presented and approved by the department.

MASTER OF SCIENCE IN ENGINEERING SCIENCE
Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science. The program of each student seeking this degree is to include at least 36 credit hours in the course sequence 3000 - 4000 in the disciplines of Engineering, Science and Mathematics. At least 12 of these 36 hours must be at the 4000 level and at least 20 hours are to be in Electrical Engineering courses. A minimum of 8 quarter hours in 4000 level Electrical Engineering courses and at least

12 credit hours in courses outside of the Electrical and Computer Engineering Department are required. All students must submit an acceptable thesis. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The department Chairman's approval is required for all programs leading to this degree.

ELECTRICAL ENGINEER

Students with strong academic backgrounds may enter a program leading to the degree Electrical Engineer.

A minimum of 72 graduate-course credits is required for the award of the engineer's degree of which at least 54 credits must be in Electrical and Computer Engineering.

Of these at least 36 hours are to be in courses in the sequence 4000 - 4999. An acceptable thesis must be completed. Approval of all programs must be obtained from the Chairman, Department of Electrical and Computer Engineering.

DOCTOR OF PHILOSOPHY

The Department of Electrical and Computer Engineering has an active program leading to the degree Doctor of Philosophy. Joint programs with other departments are possible. A noteworthy feature of these programs is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installation of the Federal Government. The degree requirements are as outlined under the general school requirements for the doctor's degree.

LABORATORIES

The laboratories of the department serve the dual role of supporting the instructional and research activities of the department. The department has well-developed laboratories in each specialty area.

The Controls Laboratory is primarily an instructional laboratory, supporting experiments in simulation and in hardware manipulation. The Circuits/Electronics Laboratory is also an instructional laboratory supporting courses in circuit analysis and design as well as electronic devices and applications.

The Digital Systems Laboratory supports both instruction and research. The laboratory is equipped with microprocessor development systems including an HP64000 for advanced course work and thesis research. CAD facilities are capable of schematic capture, circuit simulation and fault detection. Major systems in the Computer Laboratory include a modem distributed server system with a number of intelligent workstations with interactive color graphics and image processing systems. A department-wide Ethernet system provides resource-sharing and integrates these systems with office and laboratory microcomputers.

The VLSI Laboratory supports work in system design using integrated circuits and design of custom integrated circuits. Color graphic displays are used for layout of N-channel MOS (Metal-Oxide-Semiconductor) (NMOS) and Complementary MOS (CMOS) circuits.

The Optical Electronics Laboratory supports both research and courses in the areas of optics that use electronics. The laboratory has low and medium power lasers including CO lasers, an argon ion laser, a dye laser, a Nd:YAG laser and a variety of HeNe and diode lasers. A variety of detectors and imaging equipment is also available.

The Radar and EW Laboratories support courses and thesis work. Working radar systems and EW systems have been modified to allow student access to the signal processing portions of the equipment.

The Academic Computing Laboratories provide the latest SUN distributed system with three serrens and 24 workstations for student use. There are also 18 high-power i486 computers available to students.

The Microwave Laboratory provides materials, devices, components, instrumentation, computer software and systems support instructional activities and research in the frequency range from 100 MHz to 300 GHz. A high quality anechoic chamber with HP8510C Network Analyzer is available for broad band antenna pattern and impedance measurements.

The Transient Electromagnetics Scattering Laboratory supports research related to radar target classification based on broad band, impulse radar backscattering.

The Power Systems Laboratory supports research and instruction in all aspects of electric power generation, distribution and utilization.

Other support facilities within the department include the Calibration and Instrument Repair Laboratory and the Supply and Issue Facility for the ordering of instrumentation and electronic components.

COURSE OFFERINGS

EC0950 SEMINAR (No Credit).
Lectures on subjects of current interest will be presented by invited guests from other universities, government laboratories, and from industry, as well as by faculty members of the Naval Postgraduate School.

EC1010 INTRODUCTION TO MATLAB (1-0).
An introductory course for students with little or no programming background using MATLAB. Basic concepts of the MATLAB environment are considered such as matrix operations, vector and matrix manipulations, equation solving, simulation, programming, and graphing. This course prepares students for using MATLAB in future course work in the ECE department.

EC2010 PROBABILISTIC ANALYSIS OF SIGNALS AND SYSTEMS (3-1).
The foundations of signals and systems are developed from probabilistic and statistical approaches. Emphasis is on signal processing, communication systems, and computer networks relevant to military applications. Topics include probability, random variables and random sequences; density and distribution functions; deterministic versus nondeterministic signals; expectation, the d.c. and the r.m.s. values of nondeterministic signals, correlation and covariance; radar and sonar signal detection; LTI systems, transformation of random variables and the central limit theorem; basic queuing theory and computer communication networks. PREREQUISITE: EC2410 (may be concurrent).

EC2100 CIRCUIT ANALYSIS I (3-2).
An introductory course for students with no electrical engineering background. The fundamental concepts of voltage, current, power, signals, and sources are developed and applied to the analysis of resistive circuits, including simple transistor amplifiers and the operational amplifier. The principle of superposition, the one-port equivalents due to Thevevin and Norton, and the source transformation theorem are introduced. PREREQUISITES: Linear algebra and calculus (may be concurrent).

EC2110 CIRCUIT ANALYSIS II (3-2).
A continuation of EC2100. Following the introduction of energy-storage elements, dynamic circuits are analyzed with the aid of the Laplace transform. Network functions and other s-domain concepts are developed. The special case of the sinusoidal steady-state is examined using phasor methods of analysis. Frequency response, filtering, and AC power are discussed. The EC2100-2110 sequence provides background for analysis of naval electronic systems in upper division ECE courses. PREREQUISITE: EC2100.

EC2150 REVIEW OF CIRCUIT ANALYSIS (4-2).
A review of circuit analysis for students with a moderate background in electrical engineering. Starting from a review of the basic concepts of current, voltage, power, signals, and sources, the methods of dynamic circuit analysis are developed through the real and complex frequency domains. Network functions, frequency response, and AC power are included, as are the more common circuit theorems. PREREQUISITE: Some background in circuit analysis.

EC2170 ELECTRICAL ENGINEERING FUNDAMENTALS (4-2).
An introductory course for non-electrical engineering majors. The course considers network principles, signal processing circuits, natural response, forced response, total response, steady-state AC circuits, general network analysis, introduction to systems, introduction to semiconductors and semiconductor diodes, transistors and integrated circuits, and logic elements. PREREQUISITES: PH1111, PH1121, MA1117, and MA1118 or consent of instructor.

EC2200 ELECTRONICS ENGINEERING I (3-3).
An introduction to electronic devices and circuits. Electronic properties and charge-flow mechanisms of crystalline semiconductor material; properties of p-n junctions in diodes and bipolar junction transistors; static and dynamic models for these devices; applications of diodes in the design of wave shaping circuits and power supplies; applications of transistors in the design of amplifiers and digital systems; characteristics, fabrication and the design of integrated circuits. PREREQUISITE: A first course in electrical engineering.

EC2210 ELECTRONICS ENGINEERING II (3-2).
Characteristics of Field Effect Transistors (FET) including MOS and CMOS transistors and their theory of operation. Application of FET in the design of discrete amplifiers and biasing considerations. Frequency response considerations for the design of discrete device amplifiers. Application and design of feedback amplifiers and operational amplifiers. PREREQUISITE: EC2200.

EC2220 APPLIED ELECTRONICS (2-4).
A project course covering the design and applications of analog and digital integrated circuits (ICs). Includes an introductory overview of important communications ICs and practical experimental design, construction, and testing of circuits and systems using these devices. PREREQUISITES: EC2210 and EC2500.

EC2250 ACCELERATED REVIEW OF ELECTRONICS ENGINEERING (4-2).
An advanced review of semiconductor devices and circuits intended for students who have previously studied the subject matter of EC2200 and EC2210. PREREQUISITE: Sufficient background in electronic circuits. Graded on Pass/Fail basis only.

EC2270 BASIC ELECTRONICS AND ELECTRICAL MACHINES (4-2).
An introductory course for non-electrical engineering majors and a continuation of EC2170. Topics include microprocessors, operational amplifiers, large signal amplifiers, small signal models, small signal amplifiers, magnetic fields and circuits, transformers, principles of electromechanics, dc machines and ac machines, automatic control systems. PREREQUISITE: EC2170 or consent of instructor.

EC2300 CONTROL SYSTEMS (3-2).
The application of feedback principles to the design of linear control systems using frequency domain (Bode-Nichols), s-domain (root locus) and state variable methods. Performance criteria including steady-state accuracy, transient response specifications, bandwidth and integral performance indices are presented. Laboratory work includes testing and evaluation of physical systems and design studies. PREREQUISITE: EC2410.

EC2320 LINEAR SYSTEMS (3-0).
Formulation of system models including state equations, transfer functions, and system diagrams for continuous and sampled-data systems. Computer and analytical solution of system equations. Stability, controllability, and observability are defined. Introduction to design by pole placement using state feedback. PREREQUISITE: EC2410.

EC2400 DISCRETE SYSTEMS (3-2).
Principles of discrete systems, including modeling, analysis and design. Topics include difference equations, convolution, stability, bilateral z-transforms and application to right-sided and left-sided sequences, system diagrams and realizations, and frequency response. Simple digital filters are designed and analyzed. PREREQUISITE: Ability to program in a high level language (e.g., APL or MATLAB).

EC2410 ANALYSIS OF SIGNALS AND SYSTEMS (3-0).
Analysis of digital and analog signals in the frequency domain; properties and applications of the discrete Fourier transform, the Fourier series, and the continuous Fourier transform; analysis of continuous systems using convolution and frequency domain methods; applications of sampling, windowing, and amplitude modulation and demodulation systems. PREREQUISITE: EC2400.

EC2450 ACCELERATED REVIEW OF LINEAR SYSTEMS (4-0).
An advanced review of continuous and discrete system theory intended for students who have previous education in these areas. Topics covered by each student will depend upon background and competence in the subject matter of EC2400, EC2410 and EC2320. PREREQUISITE: Sufficient background in linear systems theory. Graded on Pass/Fail basis only.

EC2500 COMMUNICATIONS THEORY (3-2).
In this first course on the electrical transmission of signals, the following concepts are formulated mathematically and then considered in terms of devices and systems: sampling; pulse amplitude, position and width modulation; amplitude, phase, and frequency modulation and demodulation with analog and digital messages; time and frequency multiplexing. PREREQUISITE: EC2410.

EC2600 INTRODUCTION TO FIELDS AND WAVES (4-0).
Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions, plane wave propagation in vacuum and materials. PREREQUISITE: MA2049 or equivalent.

EC2610 ELECTROMAGNETIC ENGINEERING (3-1).
A continuation of EC2600. Topics include the analysis and design of transmission lines, waveguides, resonators, and high frequency components. Applications of military and other interest are presented in the laboratory. PREREQUISITE: EC2600.

EC2650 ACCELERATED REVIEW OF ELECTROMAGNETICS (4-2).
A comprehensive review of basic electromagnetic theory intended for students who have previously studied the subject matter of EC2600 and EC2610. PREREQUISITE: Sufficient background in electromagnetic theory. Graded on Pass/Fail basis only.

EC2800 INTRODUCTION TO MICROPROCESSORS (3-2).
An introduction to the organization and operation of microprocessors and microcomputers, both key embedded elements of military systems. Topics include: the instruction set, addressing methods, data types and number systems, stack and register organization, exception processing, assembly language programming techniques including macros, assembly language implementation of typical control structures, data structures, and subroutine linkage methods. Laboratory sessions teach a systematic method for program design and implementation. The laboratory assignments consist of a series of programs which collectively implement a major software project. PREREQUISITES: A high level language and EC2820 (may be concurrent).

EC2820 DIGITAL LOGIC CIRCUITS (3-2).
An introductory course in the analysis and design of digital circuits. These circuits are the basis for all military computers and digital control systems. No previous background in digital concepts or electrical engineering is assumed. Topics include: Boolean algebra, truth tables, logic gates, integrated circuit families, decoders, multiplexers, arithmetic circuits, PLAs, ROMs, design of combinatorial circuits using SSI and MSI components, sequential logic including latches, flip-flops, registers, (counters, and memories, analysis and design of synchronous circuits) using state tables and state diagrams. The laboratories are devoted to the study of combinatorial and sequential circuits and include a sequence of design projects involving increasingly complex digital functions.

EC2890 DIGITAL CIRCUIT DESIGN LABORATORY (0-6).
A laboratory course in the design of digital circuits. Several projects with relevance to naval and other military applications will be completed involving design with MSI

components and hardware and software control of external events with a microprocessor. Students are free to choose their projects according to their interests. PREREQUISITE: EC2800.

EC2990 DESIGN PROJECTS IN ELECTRICAL ENGINEERING (2-4).
Design projects under the supervision of faculty members. Individual or team projects involving the design of devices or systems. Projects will typically be in support of faculty members. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

EC3210 INTRODUCTION TO ELECTRO-OPTICAL ENGINEERING (3-1).
An overview of the elements that comprise current electro-optical and infrared (EO/IR) military systems. Topics include radiation sources (both laser and thermal), detector devices, modulators, optical elements, and propagation characteristics. Examples of the application of the concepts taught to various military EO/IR systems, such as missile seekers, laser communications, and laser designators are discussed. PREREQUISITE: EC2210 (may be concurrent).

EC3270 ELECTRIC POWER CONVERSION (3-2).
A detailed analytical approach is presented for the operation, performance, and control of the important types of solid state power converters found in naval shipboard power systems. The course reviews the characteristics of power semiconductor switching devices. A systems approach is used to analyze high power converters: phase controlled rectifiers, line commutated inverters, self-commutated inverters, transistor converters, and switching regulators. PREREQUISITES: EC2270 or EC2210 and electrical machine theory, or consent of instructor.

EC3310 LINEAR OPTIMAL ESTIMATION AND CONTROL (3-1).
Techniques of optimal control and estimation theory and their application to military systems. Topics include performance measures; dynamic programming, the linear regulator problem; state estimation using observers and Kalman filters; Monte Carlo simulation; combined estimation and control and case studies. PREREQUISITES: EC2300, EC2320 and one of EC3410 or EC3500 (may be concurrent).

EC3400 DIGITAL SIGNAL PROCESSING (3-1).
The foundations of digital filtering and signal processing are developed. Topics include fast Fourier transform (FFT) algorithms, block convolution, the use of DFT and FFT to evaluate convolution and correlation, design methods for non-recursive and recursive digital filters, and the Hilbert transform. Computer-aided design techniques are emphasized. Additional topics covered may include one of multirate signal processing techniques, cepstrum analysis and deconvolution, finite precision effects, and special transforms (DCT, Hartley, Walsh, etc.). The algorithms introduced have direct applications in sonar and radar signal processing, modern naval weapon systems, and also in voice and data communications. PREREQUISITE: EC2410.

EC3410 DISCRETE-TIME RANDOM PROCESSES (4-0).
Fundamentals of discrete-time random processes are developed from a probabilistic and statistical point of view for digital signal processing, control, and communications. Topics covered are random vectors and description of discrete-time random signals, sampling of continuous-time random signals, statistical averages and second moment analysis, linear transformations, and fundamentals of estimation theory. Subject matter also includes FIR optimal (Wiener) filtering, and an introduction to linear prediction. PREREQUISITES: EC2410 (may be concurrent), EC2010, and MA3042.

EC3420 STATISTICAL DIGITAL SIGNAL PROCESSING (3-1).
Modern naval systems are highly dependent on advanced statistical signal processing techniques. Modern methods of digital signal processing are developed in this course from a statistical point of view. Methods are developed for processing random signals via statistical data analysis and modeling. Topics include the IIR Wiener filter and the scalar form of the Kalman filter, linear prediction, MA, AR, and ARMA signal modeling, lattice structures, and an introduction to classical and modern methods of spectrum estimation. PREREQUISITE: EC3410.

EC3430 MULTIDIMENSIONAL DIGITAL SIGNAL PROCESSING (3-1).
Fundamentals of digital signal processing for signals that are a function of two or more independent variables. Analysis in both the time/space and frequency domains. Areas where the theory of one-dimensional signal processing does not extend in any straightforward way to two or more dimensions are highlighted. Topics include convolution, difference equations, recursively computable systems, sampling, regions of support, multidimensional periodicity, Fourier analysis including discrete Fourier transforms, z-transforms, multidimensional stability and causality, and filter design. Applications to array processing, imaging, and other areas of naval interest. (Topics may vary.) PREREQUISITE: EC2410.

EC3450 ACOUSTIC FIELD THEORY (4-0).
Introduction to various mathematical techniques (both exact and approximate), special functions (e.g., Bessel functions, Hankel functions, and Legendre polynomials), orthogonality and other relationships, that are used to solve problems concerning the radiation, scattering, and propagation of sound in fluids. Topics in underwater acoustics are emphasized and include, for example, general solutions of the three-dimensional Helmholtz equation in rectangular, cylindrical, and spherical coordinates with Dirichlet, Neumann, and Robin boundary conditions; ocean waveguide models including normal modes and a full-wave pulse propagation solution, sound propagation in the ocean - the WKB approximation, ray acoustics, and the parabolic equation approximation. PREREQUISITE: EC2610 or MA3132.

EC3500 ANALYSIS OF RANDOM SIGNALS (4-0).
Fundamental concepts necessary for handling non-deterministic signals and noise in communication, control and signal processing systems are developed. Topics include properties of random time functions, statistical averages, autocorrelation and the power spectral density, transform relations, stationarity and ergodicity, and noise models. Application to military operations are considered. PREREQUISITES: EC2500 (may be concurrent) and EC2010 or equivalent.

EC3510 COMMUNICATIONS ENGINEERING (3-1).
The influence of noise and interference on the design and selection of hardware in practical communication transmitters and receivers is analyzed. Specific topics include link and signal-to-noise ratio calculations, receiver noise performance for various modulation schemes, bandwidth trade-offs, carrier and data synchronization methods and hardware parameters. Examples of military communications systems are included. PREREQUISITES: EC2220 and EC3500 or equivalent.

EC3550 FIBER OPTIC SYSTEMS FUNDAMENTALS (3-1).
An introduction to the components and to the concepts of designing fiber optic communications systems for military applications. Includes fiber properties and parameters, fiber fabrication and testing, LED and injection laser sources, pin photodiodes and avalanche photodiode detectors, receiver design considerations, connector and splice techniques, and system design incorporating analysis and tradeoffs. Data distribution techniques are also studied. PREREQUISITES: EC2220 and EC2600.

EC3600 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (3-2).
The principles of electromagnetic radiation are applied to antenna engineering and scattering. The characteristics of various practical antenna types are considered including arrays and reflectors. Scattering concepts are introduced and propagation phenomena are considered. Applications include sidelobe suppression, radar target scattering and stealth approaches, HF and satellite communications. PREREQUISITE: EC2610 or equivalent.

EC3610 MICROWAVE CIRCUITS (3-2).
A continuation of EC2610, the course begins with a discussion of circuit media with emphasis on structures used for MICs. A study of scattering parameters and applications follows. This material is then used in the study of reciprocal and non-reciprocal components. Circuits with active devices are treated briefly. Use of CAD techniques is integrated throughout the course. PREREQUISITE: EC2610.

EC3620 MICROWAVE DEVICES (3-2).
A continuation of EC2610, the course covers microwave solid state and electron tube devices. Circuit and system applications are discussed as well as device physics. Use of CAD techniques is integrated throughout the course. PREREQUISITE: EC2610.

EC3630 RADIOWAVE PROPAGATION (3-0).
This course treats the effects of the earth and its atmosphere on electromagnetic waves in the frequency range up to about 300 GHz. Topics covered include ground waves, sky waves, meteor burst, scatter, ducting reflection, refraction, diffraction, attenuation, and fading. Basic theory is covered and computer models are introduced where appropriate. Emphasis is placed on determination of the transmission loss between transmitting and receiving antennas. Antenna parameters are covered briefly. PREREQUISITE: EC3600.

EC3640 ELECTROMAGNETIC ENVIRONMENTAL EFFECTS (3-0).
A project course covering an introduction to causes of electromagnetic interference and techniques for making electronic systems compatible. Conventional Electromagnetic Compatibility (EMC) methods and concepts are examined for receivers, transmitters, and antennas in communications, signal processing, and radar systems. Newly developed techniques that overcome the shortcomings of classical EMC test procedures and standards are emphasized. Projects are assigned from a current list of operational electromagnetic interference. Problems are provided by the Navy, Coast Guard and Marine Corps. PREREQUISITE: EC3600 or EO3760.

EC3650 COMPUTATIONAL ELECTROMAGNETIC MODELING TECHNIQUES (2-2).
Performance predictions for antennas in military systems operating below microwave frequencies are nearly impossible using conventional analytical methods. Recent advances in computers and computational electromagnetics permit efficient numerical analysis of electromagnetic radiating systems. This course introduces students to the methods of moments and finite element techniques developed for military antenna applications. Several EM modeling codes are demonstrated and used to solve typical Navy and Marine Corps antenna problems. Intended for students pursuing research in applied electromagnetics. PREREQUISITE: EC3600 or EO3760.

EC3670 PRINCIPLES OF RADAR SYSTEMS (4-2).
For students in the Avionics and Weapons curricula. Topics include microwave devices, microwave propagation, antenna fundamentals, electronically steerable arrays, pulse radar basics, detection of signals in noise, the radar equation, CW, pulse doppler, moving-target indicators, pulse compression, the ambiguity function, tracking radars, conical scan, track-while-scan, scan with compensation and monopulse. PREREQUISITES: Consent of instructor, U.S. citizenship and SECRET clearance.

EC3800 MICROPROCESSOR BASED SYSTEM DESIGN (3-2).
Advanced microprocessor system concepts are studied. Microprocessor systems are widely used for embedded control in military systems as well as for stand-alone computers. Topics covered are CPU operation and timing, address decoding, typical LSI support chips, exception processing, design of static and dynamic memory systems, worst-case timing analysis, bus arbitration, and direct memory access controllers. The laboratory consists of a design project integrating hardware and software using a state-of-the-art development system. PREREQUISITES: EC2800 and EC2820.

EC3820 COMPUTER SYSTEMS (3-1).
The course presents a unified approach for the design of computer systems stressing the interacting processes implemented in hardware, software and firmware. General features of operating systems are studied as well as specific features of an existing system. Concurrent features of the DoD-mandated language are examined. Elements of multiprogramming systems are introduced. PREREQUISITE: EC2800.

EC3830 DIGITAL COMPUTER DESIGN METHODOLOGY (3-2).
A design and project oriented course covering basic principles, theories and techniques for practical design of digital systems. Emphasizes an integrated viewpoint combining

essential elements of classical switching theory with a thorough understanding of the versatility of modern integrated circuits. Laboratory introduces modern design aids. Current military and commercial systems are used as design examples. PREREQUISITE: EC2820.

EC3840 INTRODUCTION TO COMPUTER ARCHITECTURE (3-1).
Introduction to computer organization. Fundamental principles in computer design, performance and cost tradeoffs. Instruction set architecture. Processor implementation techniques. Introduction to pipelining. Memory hierarchy design. Principles governing design of processors for embedded and military environments. Input-output subsystems for defense applications. PREREQUISITES: EC2800 and EC2820.

EC3910, EC3920...EC3990 TOPICS IN ELECTRICAL AND COMPUTER ENGINEERING (Variable Credit) (V-0).
These courses examine topics of current interest in electrical and computer engineering. PREREQUISITE: Consent of instructor.

EC4000 FUTURE ENGINEERING PRACTICE (3-0).
A survey of the fundamentals of engineering theory and practice, especially in the area of computer simulations (AI). It is designed to enable students to see trends and make future projections of practices of electrical engineering. This course concentrates on the problem presented to students by the need to learn new information as technology and careers progress. PREREQUISITE: Consent of the instructor. Graded on Pass/Fail basis only.

EC4010 PRINCIPLES OF SYSTEMS ENGINEERING (3-0).
An introduction to systems engineering processes for large-scale defense systems, including both government and industry roles. Specifically covers: determination of system requirements from operational requirements and mission needs; system acquisition, life cycle and design processes; systems engineering concepts and methods including effectiveness, reliability, maintainability, safety, logistics support, test and evaluation, cost as a design parameter; technical management methods and procedures including SEMP, CWBS, SOW, proposals, and reviews. Case studies of representative defense systems are used. An individual or class project is devoted to formulation of a systems approach to an unsolved problem. PREREQUISITE: Consent of instructor.

EC4100 ADVANCED NETWORK THEORY (3-1).
Modern active circuit design topologies; analog and sampled data networks. Analysis of transfer function properties, stability and causality. Higher order filter design and synthesis. Use of computer simulation tools, SPICE, and different device models for network analysis. Transformation methods and switched-capacitor filtering and non-filtering applications. Introduction to analog VLSI techniques using stray-insensitive switched-capacitor networks. Examples of such analog VLSI designs in military applications. PREREQUISITES: EC2210 and EC3400.

EC4210 ELECTRO-OPTIC SYSTEMS ENGINEERING (3-0).
Advanced topics and application of electro-optics. Military applications of electro-optic and infrared technology such as laser communications, laser radar, and Bragg cell signal processors. Signal-to-noise analysis of laser detector performance. Student reports on EO/IR topics of current military interest. PREREQUISITE: EC3210.

EC4300 ADVANCED TOPICS IN MODERN CONTROL THEORY (3-0).
Advanced topics and current developments in control theory and applications including such subjects as: the calculus of variations and Pontryagin's minimum principle applied to optimal control problems; numerical solution of two-point boundary-value problems; nonlinear estimation techniques; robust design techniques; large-scale systems; system identification; case studies of fire control and ship control systems. PREREQUISITE: Consent of instructor.

EC4320 DESIGN OF LINEAR CONTROL SYSTEMS (4-0).
Advanced concepts in the design of linear, nonlinear, and digital control systems. Frequency response, root locus, state feedback, parameter plane, and optimization methods are used. Applications focus on aircraft, missile, and ship control systems. SISO and MIMO systems are optimized using function minimization subroutines. Sliding mode controls are discussed. PREREQUISITE: EC3310 or consent of instructor.

EC4330 NAVIGATION, MISSILE AND AVIONICS SYSTEMS (2-2).
The principles of operation of navigation, missile, and avionics systems are presented. Topics are selected from the following areas to address the specific interests of the class: IR, EO, radar laser, and acoustic sensors; inertial platforms; gyros and accelerometers; Loran, Omega, GPS, guidance, fire control and tracking systems. PREREQUISITES: EC3310, U.S. citizenship and SECRET clearance.

EC4340 NAVIGATION, MISSILE AND AVIONICS SYSTEMS (2-2).
This course covers essentially the same material as EC4330, but with deletion of detailed analysis of specific systems. This course is intended for officers who do not have U.S. citizenship. PREREQUISITE: EC3310.

EC4350 NONLINEAR CONTROL SYSTEMS (3-1).
Automatic control of nonlinear systems with application to military systems. Analysis and design of nonlinear systems with phase plane and describing function methods. Accuracy limit cycles, jump resonances, relay servos and discontinuous systems are considered. PREREQUISITE: EC3310.

EC4360 SYSTEM IDENTIFICATION (3-1).
Design and analysis techniques of control and signal processing systems are based on a mathematical model of the system to be controlled (the plant) or a model of the environment in which they are operating (say a communication channel). In this course we address the problem of identifying mathematical models for systems based on input/output signals. Particular attention is given to linear stochastic autoregressive models of physical systems, and techniques to identify their parameters and validate the estimates. Both off line and on line (recursive) identification techniques are presented together with their properties in terms of convergence. PREREQUISITE: EC3310.

EC4370 MATHEMATICAL MODELS AND SIMULATION FOR CONTROL SYSTEMS (4-0).
Modeling concepts and techniques for linear and nonlinear systems. Philosophy of model studies. Verification of the model and its parameters. Design studies using computer models are applied to shipsteering, replenishment at sea, high speed motion picture cameras, and other naval equipment. PREREQUISITE: EC2300.

EC4400 ADVANCED TOPICS IN SIGNAL PROCESSING (3-0).
Special advanced topics in signal processing not currently covered in a regularly scheduled course and relevant to advanced naval and other military applications. Topics may include digital filter structures and implementations, advanced computational topics and architectures for signal processing, imaging, recent work in signal modeling, array processing, or other topics of interest. PREREQUISITE: EC3420 or consent of instructor.

EC4410 SPEECH SIGNAL PROCESSING (3-1).
This course covers methods of digital signal processing as they are applied to speech communication for transmission, encryption, and recognition. The production and perception mechanisms are discussed. Topics include speech modeling, analysis, synthesis, coding including LPC, and speech and speaker recognition. The techniques introduced here are also applied to sonar signal processing, voice controlled remote security and access, voice operated aircraft control, and other areas. PREREQUISITES: EC3400 and EC3420 or consent of instructor.

EC4420 MODERN SPECTRAL ESTIMATION (3-1).
Spectral estimation is the key to passive sonar detection, tracking, and identification. It also plays a dominant role in radar/sonar signature evaluation and in a majority of signal processing applications as they apply to the weapons technology of DoD. Classical and modern spectral estimation are developed from their basic ideas and compared in terms of performance and implementation. Topics covered are Fourier-based, model-based and eigenspace-based estimators, as well as Capon's method and Prony's method. Nonstationary spectral estimation schemes are discussed, in particular the Wigner-Ville distribution and the instantaneous power spectrum. Array processing is discussed from classical, model-based and eigenspace-based perspectives. Additional topics are cepstral analysis, higher order spectral estimators, and coherency. PREREQUISITES: EC3400 and EC3420.

EC4450 SONAR SYSTEMS ENGINEERING (4-1).
Mathematical development and discussion of fundamental principles that pertain to the design and operation of passive and active sonar systems critical to naval operations. Topics from complex aperture theory, array theory and signal processing are covered. This course supports the underwater acoustics and antisubmarine warfare curricula and others. PREREQUISITES: EC3450 or PH3452 or PH3402 and one of EC3410 or EC3500 or EO3720.

EC4470 ADAPTIVE SIGNAL PROCESSING (3-1).
Introduction to the theory of adaptive signal processing for random sequences. Topics covered include: review of Wiener filters and one-step forward linear prediction-error filters; (one-step backward linear prediction-error filters;) analysis and synthesis lattice prediction-error filters; adaptive tapped-delay-line filters using steepest descent, least-mean-squares (LMS) and recursive least-squares (RLS) algorithms; and adaptive lattice filters. PREREQUISITES: EC3400 and EC3420.

EC4480 IMAGE PROCESSING AND RECOGNITION (3-2).
This course provides image processing background for understanding modern military applications such as long range target selection, medium range identification, and short range guidance of new weapons systems. Subjects include image representation, enhancement, restoration, transformation, and encoding. Pattern recognition using statistical decision theory is discussed briefly. Some analysis involving region segmentation and block world understanding is introduced. Some effort is directed toward robotic vision where contemporary techniques used to recognize objects and extract depth information are dealt with briefly. The course contains a series of experiments using special peripherals and computers. PREREQUISITE: EC3430.

EC4490 OCEAN ACOUSTIC TOMOGRAPHY (3-0).
An introduction to ocean acoustic tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of ocean acoustic tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITE: EC2410 or OC3260 or PH4453 or equivalent. Also offered as OC4490.

EC4500 ADVANCED TOPICS IN COMMUNICATION (3-0).
Advanced topics and current developments in communications including such topics as: m-ary signaling in digital data transmission, packet switching in radio networks, multiple access systems, computer data links, and error control. The goal of this course is to introduce students to state-of-the-art DoD and Navy communication systems currently being used or under development. PREREQUISITE: Consent of instructor.

EC4550 DIGITAL COMMUNICATION (4-0).
This course presents some of the advantages and limitations of digital communications systems, to include: common modulation formats, matched filter receivers, probability of error calculations, non-coherent receivers, carrier synchronization, frame and bit synchronization, telephone line modems, intersymbol interference and adaptive equalizers, wideband modems, exchange of bandwidth and signal-to-noise ratio, diversity combining

maximum likelihood and maximum aposterior probability receivers, and channel capacity and finite rate communication with arbitrarily few errors. Examples of current operational and proposed military space and earth links are treated. This course serves the military education requirements of analysis, research and development, and conducting and reporting independent investigation. PREREQUISITE: EC3510 or equivalent.

EC4560 COMMUNICATIONS ECCM (3-2).
Methods of reducing the effects of jamming on radio communications systems are considered. Matched filter and correlator theory and application to spread spectrum techniques of digital data transmission are treated. Synchronization problems and techniques are presented. Codes for error correction are briefly considered. Frequency hopping, time hopping, and hybrid systems are studied in addition to direct sequence spreading. Use of steerable null antennas is described. PREREQUISITE: EC3510 or equivalent.

EC4570 DECISION AND ESTIMATION THEORY (4-0).
Principles of optimal signal processing techniques for detecting signals in noise are considered. Topics include maximum likelihood, Bayes risk, Neyman-Pearson and min-max criteria and calculations of their associated error probabilities (ROC curves) for signals in Gaussian noise. Principles of maximum likelihood, Bayes cost, minimum mean-square error (MMSE) and maximum a posteriori estimators are introduced. Asymptotic properties of estimators and the Cramer-Rao bound are developed. Integral equations and the Karhunen-Loeve expansion is introduced. The estimator-correlator structure is derived for detection of signals with unknown parameters. This structure is illustrated by development of the radar (sonar) ambiguity function and matched filter processing systems. State estimation and the Kalman filter are derived and related to MMSE estimators. Emphasis is on dual development of continuous time and discrete time approaches, the latter being most suitable for digital signal processing implementations. This course provides students the necessary foundation to undertake research in military radar and sonar systems. PREREQUISITE: EC3410 or EC3500.

EC4580 INFORMATION THEORY (4-0).
Digital military communication systems often employ error control coding to improve the effectiveness against jamming. This course together with EC4560 provide students the necessary foundations for understanding the principles of such systems. Topics include concepts of information measure for discrete and continuous signals; fundamental theorems relating to coding and channel capacity; effects of noise on information transmission; coding methods for error control in digital communications systems. Selected applications of the theory to real military systems. PREREQUISITE: EC3410 or EC3500.

EC4590 COMMUNICATIONS SATELLITE SYSTEMS ENGINEERING (3-0).
Communication satellite systems including the satellite and user terminals. Subjects include orbits, power sources, antennas, stabilization, link calculations, multiple access techniques, modulation and demodulation schemes, phase-locked loops, coding, transponder, intermodulation, and hardlimiting receiver design, spread spectrum in SITCOM for multiple access, anti-jam and covert communications. Various military satellite communications systems are introduced. PREREQUISITE: EC3510 (may be concurrent).

EC4600 ADVANCED ELECTROMAGNETIC THEORY (3-0).
An introduction is provided to advanced mathematical and numerical techniques of importance in the design and analysis of electromagnetic devices. Applications are considered for radar scattering, low observable, broad-band antennas, surface wave propagation, and microwave techniques. PREREQUISITES: EC3600 or equivalent and consent of instructor.

EC4610 RADAR SYSTEMS (3-2).
The radar range equation is developed in a form including signal integration, the effects of target cross section, fluctuations, and propagation losses. Modern techniques discussed include pulse compression frequency modulated radar, moving target indicator (MTI) and

pulse Doppler systems, monopulse tracking systems, multiple unit steerable array radars, and synthetic aperture systems. Laboratory sessions deal with basic pulse radar systems from which the advanced techniques have developed, with pulse compression, and with the measurement of radar cross section of targets. PREREQUISITES: EC3410 or EC3500, EC3600 and one among EC3610, EC3620, and EC3630; U.S. citizenship and SECRET clearance.

EC4620 RADAR SYSTEMS (3-2).
This course covers essentially the same material as EC4610, but with deletions of detailed analysis of specific items. This course is intended for students who do not have U.S. citizenship. PREREQUISITES: EC3410 or EC3500, EC3600 (or EO3760), and one among EC3610, EC3620 and EC3630.

EC4660 HIGH FREQUENCY TECHNIQUES (4-0).
The high frequency path from transmitter multicoupler to receiver multicouplers. Topics include HF propagation, propagation prediction, sounders, nuclear effects, ionospheric noise and interference, dynamic range problems, antenna and site effects, and target location techniques. Students participate in an HF system design, driven by a typical Navy HF scenario, to achieve a solution to an operational requirement. PREREQUISITES: EC3600 or consent of instructor; U.S. citizenship and SECRET clearance.

EC4670 ELECTRONIC WARFARE (4-1).
This course is intended for students who are not in the Electronics or Communications Engineering curricula. Three lecture hours are shared with EC4680. In addition to the topics listed under EC4680, background material on communication theory and digital signal processing is presented. PREREQUISITES: EC3670, U.S. citizenship and SECRET clearance.

EC4680 ELECTRONIC WARFARE TECHNIQUES AND SYSTEMS (3-3).
Active and passive countermeasure techniques are considered, including signal representation, signal analysis, and signal interception. Important parameters of radar and communications systems are defined. Denial and deceptive jamming techniques are considered along with countermeasure and counter-countermeasure techniques. Signal intercept systems are treated. Acoustic, radio-frequency, infrared, and optical countermeasures are discussed. PREREQUISITES: EC4610, U.S. citizenship and SECRET clearance.

EC4690 PRINCIPLES OF ELECTRONIC WARFARE (3-2).
For students who do not have U.S. citizenship. The objectives are to define EW signals and systems parameters, and establish interrelationships among these parameters for active and passive EW systems. Topics included are signal waveforms and spectra, receivers, signal processing and display, jamming techniques, direction finding, deception and confusion techniques. Laboratory exercises apply the basic principles of jamming and counter-countermeasures to radar systems. PREREQUISITE: EC4620.

EC4800 ADVANCED TOPICS IN COMPUTER ARCHITECTURE (3-0).
Advanced topics and current developments in computer architecture including such subjects as: RISC vs. CISC; graphics processors relevant to Naval and military applications, workstations, supercomputers and mini-supercomputers; computer structures for artificial intelligence; massively parallel architectures. PREREQUISITE: Consent of instructor.

EC4810 FAULT TOLERANT COMPUTING (3-2).
This course deals with fundamental principles of making computing more reliable in military environments. Introduction to fault tolerant computing. Fundamental definitions, goals, and applications. Failure modes, fault and error models. Passive, active, and hybrid hardware redundancy. Information, time, and software redundancy. The design of fault tolerant digital systems and VLSI circuits. Testing and evaluation of digital circuits and systems. Modeling and simulation of mission-critical fault tolerant systems. PREREQUISITES: EC3820, EC3840.

EC4820 ADVANCED COMPUTER ARCHITECTURES (3-1).
A study of advances in computer architecture. Computer descriptive languages. Memory system issues. Mini-computer and bit-slice microcomputers. High performance computers: pipeline supercomputers, array processors, multiprocessors. Data flow architectures. Fault tolerant and military architectures. PREREQUISITES: EC3820 and EC3840.

EC4830 DIGITAL COMPUTER DESIGN (3-1).
This course presents digital system design techniques that can be used in tactical embedded systems. It involves a study of the architecture of and the design process for digital computer systems. Topics covered include instruction set architectures, advanced computer arithmetic, hierarchical design techniques, design of systems using standard and custom VLSI devices. Modern computer aided design tools are emphasized. Laboratory project is the design of a digital computer. PREREQUISITES: EC3800 and EC3830.

EC4850 COMPUTER COMMUNICATION METHODS (3-0).
The course objective is to develop an understanding of computer communications network design. Coverage includes the essential topics of network topology, connectivity, queuing delay, message throughput and cost analysis. The International Standards Organization (ISO) model is divided into physical link, data link, network, transport, session and application layers. The protocol of these layers, data framing, error control, flow control, packet assembly/disassembly, routing, congestion, and virtual circuit connection are discussed. Modern networking technologies such as Ethernet, ring, satellite link, X.25 public packet switching and military data networks are introduced. PREREQUISITE: EC3410 or EC3500.

EC4870 VLSI SYSTEMS DESIGN (3-2).
An introduction to the architecture and design of very large scale integrated systems. Application to specific architectures for military systems. A structured approach to system design is developed emphasizing CMOS devices and circuits. Basic cells, state machines, and their application to highly regular topologies are studied. Special developments under the DoD VHSIC program and several examples of complete VLSI systems are presented. Project work is oriented to the definition, planning, design, and testing of a complete small system. PREREQUISITES: EC3800 and EC3830.

EC4900 SPECIAL TOPICS IN ELECTRICAL ENGINEERING (Variable credit 2-0 to 5-0) (V-0).
Supervised study in selected areas of electrical engineering to meet the needs of the individual student. A written report is required at the end of the quarter.
PREREQUISITE: Consent of the department chairman. Graded on Pass/Fail basis only.

EC4910, EC4920...EC4990 SPECIAL TOPICS IN ELECTRICAL ENGINEERING (Variable credit). (V-0).
These courses examine advanced topics of current interest in electrical and computer engineering. PREREQUISITE: Consent of instructor.

EO2710 COMM SYSTEMS I: ANALOG SIGNALS AND SYSTEMS (4-2).
A first course in communications systems for the C^3, space systems operations, and telecommunications management curricula. Coverage begins with the representation of signals in the time and frequency domains and progresses through linear system analysis using Fourier transform theory. Analog modulation techniques are presented emphasizing communications systems level analysis and spectral representation. Topics include Fourier series, Fourier transforms, linear systems, filters, signal bandwidth, communications channels, and amplitude, frequency, and phase modulation.
PREREQUISITE: MA2050 or equivalent.

EO2740 INTRODUCTION TO LINEAR SYSTEMS (4-1).
A course in the rudiments of linear systems for naval officers in the ASW and EW curricula. Principles of discrete and continuous-time systems. Topics include difference equations, discrete and continuous convolution, correlation, transfer functions, and system diagrams. Transform applications in communication and control systems.
PREREQUISITES: Integral calculus and a high level language.

EO2750 COMM SYSTEMS II: DIGITAL SIGNALS AND SYSTEMS (4-2).
A second course in communications-electronics systems for the Information Technology Management, Joint C^3 and Space Systems Operations curricula, with emphasis on digital communications systems and the effect of noise on communication systems. Specific topics include the sampling theorem; spectral representation of pulse and digital signals; pulse and digital modulation; baseband coding forms; frequency and time-division multiplexing; noise modeling, noise temperature and noise figure; signal-to-noise power ratio; and Eb/No versus bit-error rate. Partially satisfies Educational Skill Requirements for an applied, systems-level understanding of analog and digital communications systems and technologies. PREREQUISITE: EO2710.

EO2760 INTRODUCTION TO FIELDS AND WAVES (4-0).
Static field theory is developed from physical and mathematical principles. Time-varying Maxwell equations are developed and solutions to the wave equations are presented. Additional topics include boundary value problem solutions, plane wave propagation in vacuum and materials. PREREQUISITE: Vector calculus.

EO2770 ELECTROMAGNETIC ENGINEERING (3-1).
A continuation of EO2760. Topics include transmission lines, waveguides, resonators, and high frequency components. Applications are presented in the laboratory. PREREQUISITE: EO2760.

EO2790 SURVEY OF COMMUNICATION SYSTEMS (4-0).
This course supports the Intelligence curriculum by providing an overview of the principles, concepts, and tradeoffs underlying communications systems. Topics include: signals and their representation as functions of time and frequency, effects of bandwidth limitations upon signals, analog and digital modems, signal-to-noise considerations in communications systems, reliable communications path concepts, major communications system design tradeoffs, and examples of modern communications systems. PREREQUISITES: Calculus and basic electronics.

EO3720 SIGNAL PROCESSING SYSTEMS (4-1).
A course in the rudiments of modern signal processing for the ASW and EW curricula. Topics include signal processing in the frequency domain using the DFT and FFT, random signals, description and processing. Applications to signal detection, demodulation, filtering, beamforming and target tracking. PREREQUISITES: EO2740 and OS2103.

EO3740 SPACE POWER AND RADIATION EFFECTS (3-1).
Fundamentals of different power systems utilized in spacecrafts; photovoltaic power technology; solid state physics, silicon solar cells, solar cell measurement and modeling, gallium arsenide cells and III-V compounds in general, array design and solar dynamics. Radiation effects on solid state devices and materials. Survivability of solar cells and ICs in space environment and annealing methods. Other space power systems including chemical and nuclear (radioisotope thermoelectric generators, and nuclear reactors). Energy storage devices and power conversion. Spacecraft power supply design. PREREQUISITES: SS2001 and EC2200.

EO3750 COMMUNICATIONS SYSTEMS ANALYSIS (4-0).
The final course in communications systems for the C3, Space Systems Operations, and Telecommunications Management curricula. The objective is to study communications from a systems perspective concentrating on the relative performance of several important communication systems and the analysis of tradeoffs available in the design of communications systems. Specific topics introduced include relative performance of modulation types in noise, bit error rates, error detection and correction, signal-to-noise ratio, antenna characteristics, propagation, and path calculations. Special subjects are introduced and knowledge reinforced through the study of existing military communications systems. PREREQUISITE: EO2750.

EO3760 ELECTROMAGNETIC RADIATION, SCATTERING AND PROPAGATION (4-2).
The fundamentals of antennas used in the VLF through the microwave portion of the electromagnetic spectrum are presented. Scattering and propagation in this part of the

spectrum are also discussed, as are those elements of electromagnetic compatibility which relate to radiation. Laboratory exercises relating to pattern and impedance measurement, and use of computer programs further enhance the student's understanding of the lecture concepts. PREREQUISITE: EO2760.

EO3780 ELECTRONIC WARFARE COMPUTER APPLICATIONS (3-2).
Application of digital and analog techniques to the recording, processing, display, and interpretation of electronic warfare signals and data. The computer is applied to the solution of electronic warfare problems such as signal identification. PREREQUISITES: EC2820; CS3510 or CS3230; EO4780.

EO4730 ELECTRO-OPTIC SYSTEMS AND COUNTERMEASURES (3-0).
A study of military applications of electro-optic systems, IR and EO missile seekers, laser designators, optical surveillance, high energy laser systems, laser communications, and laser radar. Emphasis is on system applications, countermeasures and counter-countermeasures. Students report on electro-optic systems. PREREQUISITES: PH3208 or EC4210, U.S. citizenship and SECRET clearance.

EO4760 MICROWAVE DEVICES AND RADAR (4-2).
Those microwave devices most important in radar and in electronic warfare systems are studied, including magnetrons, traveling-wave tubes, and solid-state diodes. The radar range equation is developed. In addition to basic pulse radar, modern techniques are discussed including Doppler systems, tracking radar, pulse compression, and electronically steerable array radars. Electromagnetic compatibility problems involving radar systems from which the advanced techniques have developed, with performance measurement methods, automatic tracking systems, pulse compression, and the measurement of radar cross section of targets. PREREQUISITES: EO4720, EO3760 (may be concurrent) or consent of instructor; U.S. citizenship and SECRET clearance.

EO4780 ELECTRONIC WARFARE SYSTEMS (3-2).
This course covers electronic warfare in that portion of the electromagnetic spectrum through the millimeter wavelength region. The infrared through electro-optic region is covered in a companion course, EO4730. Electronic denial and deceptive countermeasures against fuses, communications, and various radar detection and tracking systems are discussed. Equations for required jammer gain and power output are developed. The characteristics of passive countermeasures are discussed. Other topics include anti-radiation missiles, counter-countermeasure circuits, target masking and modification, signal intercept, signal sorting, signal identification and direction finding. Techniques are discussed in relation to U.S., allied, and communist bloc systems. Laboratory work reinforces the classroom discussions. PREREQUISITES: EO4760, U.S. citizenship and SECRET clearance.

EO4790 C3 COUNTERMEASURES (V-0).
Supervised study in selected areas of electronic warfare to meet the needs of individual students. A written report is required at the end of the quarter. PREREQUISITE: Consent of C3 group chairman. Graded on a Pass/Fail basis only.

ELECTRONIC WARFARE ACADEMIC GROUP

Alfred William Madison Cooper, Professor (1957)*; PhD, The Queen's University of Belfast, 1961.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Wayne Philo Hughes, Jr., Adjunct Professor (1979); MS, Naval Postgraduate School, 1964.

Jeffrey B. Knorr, Professor (1970); PhD, Cornell University, 1970.

Arthur Loring Schoenstadt, Professor (1970); PhD, Rensselaer Polytechnic Institute, 1968.

Joseph Sternberg, Professor (1985); PhD, Johns Hopkins University, 1955.

Harold A. Titus, Professor (1962); PhD, Stanford University, 1962.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Chairman:
Joseph Sternberg
Professor
Code EW, Spanagel Hall
Room 202
(408) 656-3496
DSN 878-3496

Academic Associate:
Jeffrey B. Knorr
Professor
Code EC/Ko, Spanagel Hall
Room 428
(408) 656-2815/2082
DSN 878-2815/2082

The Electronic Warfare Academic Group is an interdisciplinary association of faculty consisting of eight members representing five separate academic disciplines. An academic group is a less formal organization than an academic department and each professor in the group has an appointment in an academic department. The Electronic Warfare Academic Group has administrative responsibility for the academic content of the Electronic Warfare Program of study. Teaching in this multidisciplinary program is carried out by faculty members attached to the following academic departments: Electrical and Computer Engineering, Mathematics, Meteorology, Operations Research and Physics. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the chairman.

MASTER OF SCIENCE IN SYSTEMS ENGINEERING

The degree Master in Science in Systems Engineering (Electronic Warfare) will be awarded at the completion of a multidisciplinary program, either Curriculum 595 or 596, satisfying the following degree requirements:

The Master of Science in Systems Engineering requires a minimum of 45 quarter hours of graduate-level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included.

An approved sequence of at least three courses constituting advanced specialization in one area must be included.

In addition to the 45 hours of course credit, an acceptable thesis must be completed.

COURSE OFFERINGS

EW0002 SEMINAR (No Credit) (0-1).
Special lectures and discussion of matters related to the Electronic Warfare program. PREREQUISITE: SECRET clearance.

EW0810 THESIS RESEARCH/GROUP PROJECT (0-0).
Students in the Systems Engineering curriculum will enroll in this course which consists of an individual thesis or a group project involving several students and faculty.

ENGINEERING ACOUSTICS ACADEMIC COMMITTEE

Chairman:
Anthony A. Atchley
Associate Professor
Code PH/Ay, Spanagel Hall
Room 101H
(408) 656-2848
DSN 878-2848

The academic character of the programs in Engineering Acoustics is interdisciplinary, with courses and laboratory work drawn principally from the fields of physics and electrical engineering. Although broadly based, the emphasis of the programs is on those aspects of acoustics, signal processing and computers related to underwater sound propagation, electro-acoustic transduction and the detection, tracking and quieting of underwater targets. These programs are designed specifically for students in the Underwater Acoustics curriculum and government employees in acoustics-related laboratories and systems commands.

The academic aspects of the program are the responsibility of an academic committee composed of representatives from the Department of Physics and of Electrical and Computer Engineering.

MASTER OF SCIENCE IN ENGINEERING ACOUSTICS

The degree Master of Science in Engineering Acoustics will be awarded as an interdisciplinary program to be carried out in accordance with the following degree requirements:

1) A student pursuing a program leading to a Master of Science in Engineering Acoustics must have completed work which would qualify him/her for a Bachelor of Science degree in engineering or physical science. Credit requirements for the Master of Science degree must be met by courses in addition to those used to satisfy this requirement.

2) The Master of Science in Engineering Acoustics requires a minimum of 36 graduate credit quarter hours of course work; at least 20 graduate quarter hours must be taken in acoustics and its applications. One 4000 level course from each of three of the following areas must be included: wave propagation, transducer theory and design sonar systems and signal processing.

3) An acceptable thesis must be completed.

Approval of each program by the Engineering Acoustics Academic Committee must be obtained prior to reaching the mid point of the degree program.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Electrical and Computer Engineering and the Department of Physics jointly sponsor an interdisciplinary program in Engineering Acoustics leading to either the degree Doctor of Philosophy or Doctor of Engineering. Areas of special strength in the departments are physical acoustics, ocean acoustics and acoustic signal processing. A noteworthy feature of this program is that a portion of the student's research may be conducted away from the Naval Postgraduate School at a cooperating laboratory or other Federal Government installation. The degree requirements and examinations are as outlined under the general school requirements for the doctor's degree. In addition to the school requirements, the departments require a preliminary examination to show evidence of acceptability as a doctoral student.

DEPARTMENT OF MATHEMATICS

Carlos Borges, Assistant Professor (1991)*; PhD, University of California, Davis, 1990.

David Canright, Assistant Professor (1988); PhD, University of California at Berkeley, 1987.

Donald Alfred Danielson, Professor (1985); PhD, Harvard University, 1968.

Fariba Fakhroo, Adjunct Professor (1992); PhD, Brown University, 1991.

Ismor Fischer, Adjunct Professor (1990); PhD, University of Wisconsin, 1989.

Richard Homer Franke, Professor and Chairman (1970); PhD, University of Utah, 1970.

Harold M. Fredricksen, Professor (1980); PhD, University of Southern California, 1968.

Christopher Frenzen, Associate Professor (1989); PhD, University of Washington, 1982.

William Gragg, Professor (1987); PhD, University of California at Los Angeles, 1964.

Teresa Henson, Adjunct Professor (1991); MS, University of Colorado at Denver, 1989.

Van Emden Henson, Assistant Professor (1991); PhD, University of Colorado at Denver, 1990.

David S. Herscovici, Adjunct Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

Toke Jayachandran, Associate Dean of Faculty and Graduate Studies, Professor (1967); PhD, Case Institute of Technology, 1967.

Jeffery Leader, Assistant Professor (1990); PhD, Brown University, 1989.

Bard Mansager, Adjunct Professor (1991); MA, University of California, San Diego, 1979.

Beny Neta, Professor (1985); PhD, Carnegie-Mellon University, 1977.

Guillermo Owen, Professor (1983); PhD, Princeton University, 1962.

Craig S. Peters, Adjunct Professor (1992); PhD, University of California, Davis, 1987.

Craig Rasmussen, Assistant Professor (1991); PhD, University of Colorado at Denver, 1990.

Chairman:
Richard H. Franke
Professor
Code MA/Fe, Ingersoll Hall
Room 344
(408) 656-2206
DSN 878-2206

Associate Chairmen:

Labs and Computing
Arthur Schoenstadt
Professor
Code MA/Zh, Ingersoll Hall
Room 334
(408) 656-2662
DSN 878-2662

Research
Beny Neta
Professor
Code MA/Nd, Ingersoll Hall
Room 348
(408) 656-2235
DSN 878-2235

Instruction and Recruiting
Guillermo Owen
Professor
Code MA/On, Ingersoll Hall
Room 341
(408) 656-2720
DSN 878-2720

Ira Bert Russak, Associate Professor (1972); PhD, University of California at Los Angeles, 1967.

Clyde Scandrett, Associate Professor (1987); PhD, Northwestern University, 1985.

Arthur Schoenstadt, Professor (1970); PhD, Rensselaer Polytechnic Institute, 1968.

Aihua Shaker, Adjunct Professor (1990); PhD, University of Connecticut, 1990.

John Thornton, Assistant Professor (1989); PhD, Clemson University, 1989.

Maurice Dean Weir, Associate Dean of Instruction, Professor (1969); DA, Carnegie-Mellon University, 1970.

The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

As well as the master of science degree and Ph.D. program in Applied Mathematics, the Mathematics Department offers individually tailored minor programs for many of the school's doctoral students. The majority of the departmental effort is devoted to the service courses offered, including the refreshers and 1000-3000 level courses. The department maintains a microprocessor lab for purposes of instruction.

MASTER OF SCIENCE IN APPLIED MATHEMATICS

In order to enter a program leading to the degree Master of Science in Applied Mathematics, a student must be qualified by background for a Bachelor of Science degree with a major in mathematics or with a strong mathematical orientation in physical science or engineering.

A program that leads to the degree Master of Science in Applied Mathematics for a student who has met the entrance criteria must contain a minimum of 45-quarter hours of graduate-level courses with a minimum QPR of 3.0, subject to the following conditions:

1) The program must be approved by the Chairman of the Department of Mathematics.

2) The program must include at least fifteen hours at the 4000 level, with at least twelve hours in 4000 level mathematics courses.

3) The program must contain at least nine hours in an approved sequence of application courses from within the Mathematics Department, or outside the department.

4) An acceptable thesis is normally required and is credited as the equivalent of nine hours of 3000 level mathematics courses. A student receiving a dual masters and writing a thesis in another department may petition the Chairman of the Mathematics Department to substitute 2 or 3 approved courses for the thesis. The thesis, however, must contain a strong mathematical content.

5) Courses in the following areas are specifically required in any program; some of these courses may be used to satisfy part (or all) of the mathematics sequence requirement in item (3) above:

   a. Real Analysis (a two-course sequence) and Modern Applied Algebra;

   b. Ordinary and Partial Differential Equations;

   c. Numerical Analysis;

   d. Probability and Statistics;

   e. Linear Algebra (a two-course sequence);

   f. Mathematical Modeling Processes.

DOCTOR OF PHILOSOPHY

The Department of Mathematics offers the degree Doctor of Philosophy in Applied Mathematics. Areas of specialization will be determined by the department on a case by case basis. Requirements for the degree include course work followed by an examination in both major and minor fields of study, and research culminating in an approved dissertation. It may be possible for the dissertation research to be conducted off-campus in the candidate's sponsoring organization.

Entrance into the program will ordinarily require a master's degree, although exceptionally well prepared students with a bachelor's degree may be admitted. A preliminary examination may be required to show evidence of acceptability as a doctoral student. Prospective students should contact the Chairman of the Mathematics Department for further guidance.

COURSE SEQUENCES FOR SPECIAL CURRICULA

The Mathematics Department offers several sequences of courses for various curricula. Students of these curricula typically enter these sequences at their appropriate level and exit when completing their particular requirements.

COMPUTER SCIENCE

MA2025
MA3026

MANAGEMENT

MA2300

OPERATIONAL CURRICULA

MA2138
MA3139

ENGINEERING SCIENCE

MA0142 or MA1042
MA1117
MA1118
MA2049
MA2121
MA3132
MA3232

OPERATIONS RESEARCH

MA0142 or MA1042
MA1118
MA3042
MA3110

PREREQUISITES

Prerequisites are as described in the course descriptions. If a student has not taken the prescribed prerequisites at NPS, then a validation examination by the Mathematics Department may be substituted.

Generally speaking, credit for courses given in sequences will not be available to every student. Credit will be given for only one of a pair of equivalent courses.

COURSE OFFERINGS

MA0117 REFRESHER: SINGLE VARIABLE CALCULUS (NO CREDIT) (Meets las 6 weeks of quarter) (3-3).
Single variable calculus review.

MA0118 REFRESHER: MULTIVARIABLE CALCULUS (NO CREDIT) (Meets last weeks of quarter) (3-3).
Multivariable calculus review.

MA0125 INTRODUCTION TO FINITE MATHEMATICS (NO CREDIT) (Meets last 6 weeks of quarter) (3-0).
An introduction to the elements of set theory and mathematical reasoning. Sets, Venn diagrams, truth tables, quantifiers, logical reasoning. Functions, relations, partitions and equivalence relations. 1-1 correspondence. Applications of finite mathematics such as finite difference equations, counting problems, geometric linear programming and so forth are included.

MA0142 REFRESHER: MATRIX ALGEBRA (NO CREDIT) (Meets last six weeks of quarter) (2-0).
The fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to mxn systems of linear algebraic equations are also investigated including Gaussian elimination and the LU decomposition of a matrix (without pivoting). Determinants, properties of determinants and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

MA1042 MATRIX ALGEBRA (2-0).
The fundamental algebra of matrices including addition, multiplication of matrices, multiplication of a matrix by a constant and a column (vector) by a matrix. Elementary matrices and inverses, together with the properties of these operations. Solutions to mxn systems of linear algebraic equations are also investigated including Gaussian elimination and the LU decomposition of a matrix (without pivoting). Determinants, properties of determinants and Cramer's rule for solving square systems; introduction to eigenvalues. A brief introduction to the arithmetic of complex numbers and DeMoivre's theorem.

MA1117 SINGLE VARIABLE CALCULUS (5-2).
Review of analytic geometry and trigonometry, functions of one variable, limits, derivatives, continuity and differentiability; differentiation of algebraic, trigonometric, logarithmic and exponential functions with applications to maxima and minima, rates, differentials; product rule, quotient rule, chain rule; anti-derivatives, integrals and the fundamental theorem of calculus; definite integrals, areas, lengths of curves and physical applications; special methods of integration, including a two-hour problem-solving laboratory. PREREQUISITE: Precalculus mathematics.

MA1118 MULTIVARIABLE CALCULUS (5-2).
Polar coordinates and parametric equations, vector algebra and calculus, directional derivative, gradient; maxima and minima of functions of two independent variables, total differential; double and triple integrals, cylindrical and spherical coordinate systems; infinite series, convergence tests and Taylor series, including a two-hour problem-solving laboratory. PREREQUISITE: Previous course in calculus.

MA1248 SELECTED TOPICS IN APPLIED MATHEMATICS FOR MANAGEMENT (4-1).
A survey of selected calculus and post-calculus topics - infinite sequences and series; Fourier series and Fourier integral transforms; and matrix algebra and determinants. (This course may not be taken for credit by students in an engineering or science degree program). PREREQUISITE: MA1117.

MA2025 BRIDGE TO ADVANCED MATHEMATICS (4-1). Propositional and predicate logic, elements of set theory, relations, functions and partitions. An introduction to theorem proving techniques, including mathematical induction, in the context of basic mathematical systems applied to computer science.

MA2049 VECTOR ANALYSIS WITH APPLICATIONS (3-0).
Brief review of vector algebra. The calculus of vector fields; directional derivative, gradient, divergence, curl; potential functions; Green's, Stokes' and the divergence integral

theorems. Index and dyadic notation. Generalized orthogonal coordinates. Applications include the geometry of curves and surfaces, heat and fluid flow, classical mechanics, and electromagnetism. PREREQUISITES: MA1118 and MA0142 or MA1042.

MA2121 DIFFERENTIAL EQUATIONS (4-0).
Ordinary differential equations: linear and nonlinear (first order) equations, homogeneous and non-homogeneous equations, linear independence of solutions, power series solutions, systems of differential equations, Laplace transforms. Applications. Course covers basic material essential for engineering and physical science. PREREQUISITES: MA1118 or equivalent, MA1042 or equivalent concurrently.

MA2138 SELECTED TOPICS FROM CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS (5-0).
Partial derivatives, directional derivatives, tangent planes. Multiple integrals in rectangular, polar, cylindrical and spherical coordinates. First order ordinary differential equations, second order linear equations with constant coefficients, Laplace transforms. Applications include filtering of electronic signals, e.g., radar or sonar. For ASW and EW students only. PREREQUISITE: MA1117 or equivalent.

MA2300 MATHEMATICS FOR MANAGEMENT (5-0).
Mathematical basis for modern managerial tools and techniques with emphasis on militar applications. Elements of differential and integral calculus. Introduction to matrix algebra and solutions of linear systems of algebraic equations. PREREQUISITE: College algebra.

MA3001 INCREMENTED DIRECTED STUDY (1-0).
Provides the opportunity for a student who is enrolled in a 3000-level course to pursue the course material and its applications in greater depth by directed study to the extent of one additional hour beyond the normal course credit.

MA3002 INCREMENTED DIRECTED STUDY (2-0).
Provides the opportunity for a student who is enrolled on a 3000-level course to pursue the course material and its applications in greater depth by directed study to the extent of two additional hours beyond the normal course credit.

MA3026 DISCRETE MATHEMATICS WITH APPLICATIONS (5-0).
Graphs, trees, matchings and network flows. Introduction to combinatorial problems and counting techniques. Recurrence relations. Combinatorial circuits and introduction to finit state machines. Applications to computer science. PREREQUISITE: MA2025.

MA3042 LINEAR ALGEBRA (4.0).
Finite dimensional vector spaces, linear dependence, basis, dimension, inner products, orthogonalization. Linear transformations, rank and nullity, change of basis, linear functionals, orthogonal transformations, quadratic forms, symmetric matrices, diagonalization, eigenvalues and eigenvectors. PREREQUISITES: MA1118 taken concurrently, MA1042.

MA3046 MATRIX THEORY AND COMPUTATIONAL LINEAR ALGEBRA (4-1).
Review of linear algebra from a computationally constructive and geometric point of view: Gauss factorization, fundamental theorem of linear algebra. Linear least squares problem via modified Gram-Schmidt and Householder QR factorizations. Algorithms for updating matrix factorizations: application to linear programming. Hermitian eigenproblems and singular value decompositions via the QR algorithm and divide-and-conquer algorithms. Lanczos and Arnoldi processes. Structured problems arising in signal processing: fast Fourier transforms, Toeplitz systems, orthogonal eigenproblems. Coding of algorithms using Matlab. PREREQUISITE: MA3042 or consent of instructor.

MA3110 INTERMEDIATE ANALYSIS (4-0).
Multivariable calculus integrated with linear algebra. Functions of several variables, continuous transformations, Jacobians, chain rule, implicit function theorem, inverse function theorem, extrema, optimization and Lagrange multiplier technique. PREREQUISITES: MA1118 or equivalent, MA3042 or equivalent.

MA3132 PARTIAL DIFFERENTIAL EQUATIONS AND INTEGRAL TRANSFORMS (4-0).
Solution of boundary value problems by separation of variables; Sturm-Liouville problems; Fourier, Bessel and Legendre series solutions, Fourier transforms; classification of second order equations; applications, method of characteristics. Applications to engineering and physical science. Satisfies the ESR in differential equations for the applied mathematics program. PREREQUISITE: MA2121 or equivalent.

MA3139 FOURIER ANALYSIS AND PARTIAL DIFFERENTIAL EQUATIONS (4-0).
Fourier series; solution of the one and two-dimensional wave equations, D'Alembert's solution, frequency and time domain interpretations; Fourier integral transforms and applications to ordinary and partial differential equations and linear systems; Convolution theorems. Course covers basic material essential for engineering and science; applications include spectral analysis of elctronic signals, e.g., radar or sonar. For ASW and EW students. PREREQUISITE: MA2138.

MA3185 TENSOR ANALYSIS (3-0).
Definition and algebra of tensors. Dyadic representation in Cartesian and general components. Calculus of tensor fields in curvilinear coordinates. Derivation and application of the basic equations of: heat conduction, rigid body mechanics, elasticity, fluid mechanics, electromagnetism, Newtonian and Einsteinian orbital mechanics.

MA3232 NUMERICAL ANALYSIS (4-1).
Provides the basic numerical tools for understanding more advanced numerical methods, including finite difference, finite element and boundary element methods. Topics for the course include: solution of nonlinear equations, interpolation, numerical integration and differentiation, numerical solution of ODE's and BVP's, numerical linear algebra and the eigenvalue problem, and analysis of computational errors. PREREQUISITE: MA2121 or equivalent (may be taken concurrently) and FORTRAN programming

MA3243 NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (4-1).
Course designed to familiarize the student with classical finite difference techniques in the numerical solution of partial differential equation. In addition to learning some of the applicable algorithms, the students will be required to do some programming in FORTRAN. Topics covered include: implicit, explicit, and semi-implicit methods in the solution of elliptic and parabolic PDE's, iterative methods for solving elliptic PDE's (SOR, Gauss-Seidel, Jacobi), the Lax-Wendroff and explicit methods in the solution of the 1st and 2nd order hyperbolic PDE's. PREREQUISITE: MA3132 and FORTRAN programming.

MA3393 TOPICS IN APPLIED MATHEMATICS (Variable hours 1-0 to 4-0) (V-0).
A selection of topics in applied mathematics. The course content varies and the credit varies. This course is intended to reflect study for the beginning graduate student in an area for which no formal course is taught. Credit for this course may be granted more than one time to an individual student. PREREQUISITE: Consent of instructor.

MA3400 MATHEMATICAL MODELING PROCESSES (4-0).
Practice model construction while demonstrating the utility and universality of mathematics. Topics include modeling using graphical analysis, the model building process, modeling using proportionality, analysis of data, modeling using dimensional analysis, dynamical models, optimization of models and simulation. Models investigated include the nuclear arms race, drag force on a submarine, optimization of inventory levels and fuel consumption. PREREQUISITE: MA1118 or consent of instructor.

MA3560 MODERN APPLIED ALGEBRA (3-0).
The techniques and tools of abstract algebra. Elements of set theory, equivalence relations and partitions. Semi-groups, groups, subgroups and homomorphisms. Ring, ideals and fields. Directed graphs and lattices. Applications may vary, but typically are drawn from topics of interest to DoN/DoD. These include error correcting codes, reliable and secure

communications, cryptography, etc. Satisfies the algebra ESR for the applied mathematics program. PREREQUISITE: MA3042 or consent of instructor.

MA3565 MODERN ALGEBRA (3-0).
An advanced course in the subject of abstract algebra. Semi-groups, groups, subgroups, normal subgroups. Groups acting on sets, operator groups. The Jordan-Holder Theorem, solvable groups. The Krull-Schmidt Theorem. PREREQUISITE: Consent of instructor.

MA3605 FUNDAMENTALS OF ANALYSIS I (3-0).
The real number system and the usual topology of the real line; properties of continuous functions; differentiation. Functions of bounded variation and theory of Reiman-Stieltjes integration, convergence theorems for sequence and series of functions. Satisfies the analysis ESR for the applied mathematics program. PREREQUISITE: MA3110 or consent of instructor.

MA3606 FUNDAMENTALS OF ANALYSIS II (3-0).
Continuation of MA3605. PREREQUISITE: MA3605.

MA3610 TOPOLOGY, FRACTALS AND CHAOTIC DYNAMICS (3-0).
An introductory course on fractals and chaotic dynamics utilizing techniques and ideas of metric space topology. Topics covered include: metric and topological spaces, completeness, the Hausdorff metric on the "space of fractals", affine transformations, iterated function systems, computer generation of fractals, dynamical systems, shift maps on code spaces, characterizations of chaotic dynamics, fractal dimension. Applications include feedback in predator-prey models, light emissions by cluster groups, photosynthesis and electrical circuits. PREREQUSISITE: Consent of instructor, MA3605 recommended.

MA3675 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE I (3-0).
Selected topics from the theory of functions of a complex variable, complex functions, power series, Laurent series. Singularities of complex functions; contour integration and residues; zeros of analytic functions, factors of and infinite product representation for analytic functions; maximum modulus theorems for analytic and harmonic functions; conformal mapping. Applications include interference effects in optics and problems from heat flow and fluid flow. PREREQUISITE: Consent of instructor.

MA3676 THEORY OF FUNCTIONS OF A COMPLEX VARIABLE II (3-0).
Continuation of MA3675. PREREQUISITE: MA3675.

MA3730 THEORY OF NUMERICAL COMPUTATION (3-0).
Analysis of computational methods used for the solution of problems from the areas of algebraic equations, polynomial approximation, numerical differentiation and integration and numerical solutions of ordinary differential equations. PREREQUISITE: Consent of instructor.

MA4026 COMBINATORIAL MATHEMATICS (4-0).
Advanced techniques in the computational counting process. Enumerative algorithms are analyzed. The systematic analysis of different possibilities, the exploration of logical structure and the application of intuitive insight are stressed. Numerical examples to display these concepts are developed. PREREQUISITE: MA3026.

MA4027 GRAPH THEORY AND APPLICATIONS (4-0).
Advanced topics in graph theory with an emphasis on communication networks, flows, phasing of signals and scheduling. Students learn to implement new graph theory techniques in their area of study. Further models in such areas as energy use and air flow will be examined, in addition to the core material. PREREQUISITE: MA3026.
mathematics course to pursue the subject under faculty supervision to a greater depth. Two extra credits are assigned beyond the normal course credit. PREREQUISITES: Enrollment in a 4000-level math course and consent of instructor.

MA4103 THESIS TOPICS SEMINAR (3-0).
Explores in-depth the thesis topics of students enrolled in the mathematics degree program. Fulfills the ESR to provide students with the experience of organizing and presenting applied mathematical ideas to students and faculty, including a classroom environment. PREREQUISITE: Consent of instructor. Graded on Pass/Fail basis only.

MA4230 NUMERICAL FUNCTIONAL ANALYSIS (3-0).
Linear functions, Riesz representation theorem, Hilbert spaces, Sobolev space, interpolation and approximation in Hilbert spaces, nonlinear operators, Newton's method. PREREQUISITES: MA3232, MA4635.

MA4237 ADVANCED TOPICS IN NUMERICAL ANALYSIS (Variable credit, usually 4-0).
The subject matter will vary according to the abilities and interests of those enrolled. Applications of the subject matter are discussed. PREREQUISITE: Consent of instructor.

MA4243 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (3-1).
Finite difference methods for parabolic elliptic, and hyperbolic equations, mult-grid methods; convergence and stability, error estimation and control, numerical solution of finite difference equation, applications. PREREQUISITES: MA3232, MA3132.

MA4245 FINITE ELEMENT METHODS (3-0).
Variational formulation of boundary value problems, finite element and boundary element approximations, types of elements, stability, eigenvalue problems. PREREQUISITES: MA3232, MA3132.

MA4248 MATRIX COMPUTATION (3-1).
Numerical algorithms for matrix computation and anlaysis of them, orthogonalization and least squares, eigenvalue problems, iterative methods for linear systems, methods for special problems. PREREQUISITES: MA3232, MA3046.

MA4311 CALCULUS OF VARIATIONS (3-0).
Euler equation, Weierstrass maximum principle. Legendre condition, numerical procedures for determining solutions, gradient methods, Newton's method, tranversality condition. Rayleigh-Ritz method, conjugate points. Applications to flight mechanics. PREREQUISITE: MA2121 (programming experience desirable).

MA4312 TOPICS IN CALCULUS OF VARIATIONS (3-0).
Recent development of the numerical solution of problems in the calculus of variations. Foundations of numerical methods, applications to control problems. Differentials, perturbations, variational equations, adjoint systems, conditions for optimum. Euler equations, maximum principle of Weierstrass and Pontryagin, the Legendre condition. Methods of solution: special variations, variation of extremals, dynamic programming. Applications in ship routing and missile control. PREREQUISITES: MA4311 and computer programming.

MA4322 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS I (3-0).
Linear operators, generalized functions and Hilbert spaces; solutions of partial differential equations by Green's functions and eigenfunctions; variational techniques; Fredholm and Volterra integral equations; asymptotic methods and perturbations. Applications to wave propagation, optimization, fluid dynamics, and numerical methods. PREREQUISITE: MA3132 or equivalent.

MA4323 PRINCIPLES AND TECHNIQUES OF APPLIED MATHEMATICS II (3-0).
Continuation of MA4322. PREREQUISITE: MA4322.

MA4362 ORBITAL MECHANICS (3-0).
Coordinate systems and transformations. Review of Newtonian mechanics and the two-body problem. The gravitational potential. Perturbation. Analytical and numerical techniques for predicting the orbits of artificial satellites and space vehicles.

MA4372 INTEGRAL TRANSFORMS (3-0).
The Laplace, Fourier and Hankel transforms and their inversions; Asymptotic behavior. Applications to problems in engineering and physics. PREREQUISITE: Consent of instructor.

MA4391 ANALYTICAL METHODS FOR FLUID DYNAMICS (4-0).
The basic fluid dynamic equations will be derived and a variety of analytical methods will be applied to problems in viscous flow, potential flow, boundary layers and turbulence. Applications in aeronautics will be discussed. PREREQUISITE: MA3132 or MA3139 or consent of instructor.

MA4392 NUMERICAL METHODS FOR FLUID DYNAMICS (4-0).
Numerical methods exclusively will be applied to fluid dynamics problems in viscous flow, potential flow, boundary layers and turbulence. Applications in aeronautics will be discussed. PREREQUISITES: MA4391 and MA3232 or consent of instructor.

MA4393 TOPICS IN APPLIED MATHEMATICS (3-0).
A selection of topics in applied mathematics. The course content varies, but applications of interest to the DoN/DoD will be discussed. Credit may be granted for taking this course more than once. PREREQUISITE: Consent of instructor.

MA4560 CODING AND INFORMATION THEORY (4-0).
Mathematical analysis of the codes used over communication channels is made. Techniques developed for efficient, reliable and secure communication are stressed. Effects of noise on information transmission are analyzed and techniques to combat their effects are developed. Linear codes, finite fields, single and multiple error correcting codes are discussed. Codes have numerous applications for communication in the military, and these will be addressed. PREREQUISITE: MA3560.

MA4565 ADVANCED MODERN ALGEBRA (3-0).
A continuation of MA3565. Rings, ring homomorphism, integral domains and euclidean domains. Unique factorization rings, polynomial rings. Modules and ideals. Noetherian rings, Field extension and Galois theory. PREREQUISITE: MA3565, or consent of instructor.

MA4570 CRYPTOGRAPHY (4-0).
The methods of secret communication are addressed. Some simple cryptosystems are described and classical techniques of substitution and transposition are considered. The public-key cryptosystems, RSA, Discrete Logarithm and other schemes are introduced. Applications of cryptography and cryptanalysis have had significant effect in warfare since WWII. PREREQUISITE: MA3560.

MA4593 TOPICS IN ALGEBRA (3-0).
A selection of topics in algebra. Content of the course varies. Students may select a topic of interest to the DoN/DoD so the course can support the ESR's in a variety of curricula. Credit for taking the course more than once is allowed. PREREQUISITE: Consent of instructor.

MA4595 MATHEMATICAL FOUNDATIONS OF FAST SIGNAL PROCESSING ALGORITHMS (3-0).
Advanced transform algorithms for signal processing. Generalized Cooley-Tukey, Rader prime factor and Winograd FFT algorithms. Polynomial rings, the Chinese Remainder theorem for polynomials, quotient fields and reduced multiplication convolution algorithms. Applications to hardware and software design for signal processing systems. PREREQUISITE: EC3400 or equivalent.

MA4620 THEORY OF ORDINARY DIFFERENTIAL EQUATIONS (3-0).
Introduction to the modern theory of ordinary differential equations. Systems of equations. Theoretical and constructive methods of solutions. PREREQUISITE: Consent of instructor

MA4635 FUNCTIONS OF REAL VARIABLES I (3-0).
Semi-continuous functions, absolutely continuous functions, functions of bounded variation; classical Lebesque measure and integration theory, convergence theorems and Lp spaces. Abstract measure and integration theory, signed measures, Radon-Nikodym theorem; Lebesque decomposition and product measure; Daniell integrals and integral representation of linear functionals. PREREQUISITE: MA3606.

MA4636 FUNCTIONS OF REAL VARIABLES II (3-0).
Continuation of MA4635. PREREQUISITE: MA4635.

MA4693 TOPICS IN ANALYSIS (3-0).
A selection of topics in analysis. Content of the course varies. Students will be allowed credit for taking the course more than once. PREREQUISITE: Consent of instructor.

DOCTOR OF PHILOSOPHY COURSE OFFERINGS

MA4242 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS (3-1).
Adams formulas, Runge-Kutta formulas, extrapolation methods, implicit formulas for stiff equations; convergence and stability, error estimation and control, order and stepsize selection, applications. PREREQUISITE: MA3232.

MA4251 APPLIED APPROXIMATION THEORY (3-1).
Univariate and tensor product spline approximation, interpolation in Hilbert spaces, scattered data approximation, applications. PREREQUISITES: MA3232, MA4230.

MA4261 PARALLEL SCIENTIFIC COMPUTATION (3-2).
A selection of parallel algorithms to solve important and commonly occurring problems encountered in scientific computing: linear systems, QR factorization, symmetric and unsymmetric eigenvalue problems, singular value decomposition, fast Fourier transform, partial differential equations, numerical quadrature, divide and conquer algorithms. Programming assignments to be included. PREREQUISITE: MA3261.

MA4321 STABILITY, BIFURCATION AND CHAOS (3-0).
Differential equations and dynamical systems, equilibrium of autonomous systems, stability, Liapunov's method, examples of chaos, local bifurcations of vector fields and maps, chaotic dynamical systems. PREREQUISITE: MA4620.

MA4332 PARTIAL DIFFERENTIAL EQUATIONS (3-0).
Diffusion, wave and Laplace equations. Classification of second order equation discontinuities and signal propagation, transform methods, Green's functions, first order equations and characteristics. PREREQUISITE: MA3132.

MA4335 LINEAR AND NONLINEAR WAVES (3-0).
Analysis of the two main classes of wave motion, hyperbolic waves and linear dispersive waves. Topics covered include: kinematic waves, shock waves, shock structure and shock fitting, Burger's equation, the wave equation, linear dispersive waves, wave patterns and water waves. PREREQUISITE: MA3132.

MA4340 ADVANCED MATHEMATICAL MODELING (3-0).
A course intended to bring advanced mathematical methods to bear on the modeling and the study of physical problems. Topics to be discussed include: simple dynamic models, the phase plane, stable and unstable motion, wave motion, bifurcation, catastrophe and chaos. PREREQUISITES: MA3400, MA3132, MA4377, MA4332, MA4620.

MA4377-8 ASYMPTOTIC AND PERTURBATION METHODS (3-0).
Advanced courses in the application of approximate methods to the study of integrals and differential equations arising in physical problems. Topics covered include: asymptotic sequences and expansions, integrals of a real variable, contour integrals, limit process expansions applied to ordinary differential equations, multiple variable expansion procedures and applications to partial differential equations. PREREQUISITE: MA3132.

MA4390 MATHEMATICS OF CONTINUUM MECHANICS (4-0). The equation of the mechanics of all deformable continua (solids, fluids) will be derived. Topics include: Euclerian and Lagrangian coordinates, stress tensor, constitutive relations, isotropic and anisotropic materials. PREREQUISITE: MA3132.

MA4399 DISSERTATION RESEARCH (variable credit).

MA4675 COMPLEX ANALYSIS (3-0).
A continuation of MA3675, MA3676. Differential equations in the complex plane, transform methods, the Wiener-Hopf method, integral equations, discrete Fourier analysis. PREREQUISITES: MA3675, MA3676.

DEPARTMENT OF MECHANICAL ENGINEERING

Chairman:
Matthew D. Kelleher
Professor
Code ME/Kk, Halligan Hall
Room M-4
(408) 656-2586
DSN 878-2586
FAX (408) 656-2238

Associate Chairmen:

Operations:
Terry R. McNelley
Professor
Code ME/Mc, Spanagel Hall
Room 250
(408) 656-2589
DSN 878-2589

Research:
Young Sik Shin
Professor
Code ME/Sg, Halligan Hall
Room 209A
(408) 656-2568
DSN 878-2568

Virendra Charan, Adjunct Teaching Professor (1992); PhD, London University, 1967.

Roy Crooks, Adjunct Teaching Professor (1990); PhD, Georgia Institute of Technology, 1982.

Morris Driels, Professor (1989); PhD, City University, London, 1973.

Indranath Dutta, Assistant Professor (1988); PhD, University of Texas, Austin, 1988.

Alan G. Fox, Associate Professor (1989); PhD, University of Birmingham, United Kingdom, 1982.

James F. Hallock, Adjunct Teaching Professor (1989); MS, Massachusetts Institute of Technology, 1965.

Anthony Healey, Professor (1986); PhD, Sheffield University, United Kingdom, 1966.

Yogendra Joshi, Associate Professor (1986); PhD, University of Pennsylvania, 1984.

Matthew Dennis Kelleher, Chairman and Professor (1967); PhD, University of Notre Dame, 1966.

Joung Kook Kim, Adjunct Professor (1992); MS, University of Illinois, 1985.

Young W. Kwon, Assistant Professor (1990); PhD, Rice University, 1985.

Paul James Marto, Dean of Research, Distinguished Professor (1965); ScD, Massachusetts Institute of Technology, 1965.

Terry Robert McNelley, Professor (1976); PhD, Stanford University, 1973.

Steven Memory, Adjunct Teaching Professor (1990); PhD, London University, 1990.

Knox Taylor Millsaps, Jr., Assistant Professor (1992); PhD, Massachusetts Institute of Technology, 1992.

Shantanu Mitra, Adjunct Teaching Professor (1991), PhD, University of Texas, Austin, 1989.

Ranjan Mukherjee, Assistant Professor (1991), PhD, University of California, Santa Barbara, 1989.

Devadatta Mukutmoni, Adjunct Research Professor (1991), PhD, University of Notre Dame, 1991.

Arthur Jeffrey Perkins, Professor (1972); PhD, Case Western Reserve University, 1969.

David Salinas, Associate Professor (1970); PhD, University of California, Los Angeles, 1968.

Turgut Sarpkaya, Distinguished Professor (1967); PhD, University of Iowa, 1954.

Young Sik Shin, Professor (1981); PhD, Case Western Reserve University, 1971.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The department of Mechanical Engineering provides a strong academic program which spans across the discipline areas of structural mechanics, dynamics and control, materials science and the thermal-fluid sciences. These disciplines are blended together with an emphasis on naval engineering applications such as may be experienced on surface vessels and in submarines.

Programs leading to the degree Master of Science in Mechanical Engineering are accredited at the advanced level by the Engineering Accreditation Commission of the Accreditation Board for Engineering and Technology.

A specific curriculum must be consistent with the general minimum requirements for the degree as determined by the Academic Council.

Any program leading to award of a degree must be approved by the Chairman of the Department of Mechanical Engineering at least two quarters before completion. In general, approved programs will require more than minimum degree requirements in order to conform to the needs and objectives of the United States Navy.

MASTER OF SCIENCE IN MECHANICAL ENGINEERING

A candidate shall have completed work equivalent to the Bachelor of Science requirements of this department. Candidates who have not majored in Mechanical Engineering, or who have experienced a significant lapse in continuity with previous academic work, initially will take undergraduate courses in mechanical engineering and mathematics in preparation for their graduate program.

The candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements below.

The Master of Science degree in Mechanical Engineering requires at least 32 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 12 of which must be at the 4000 level. In addition, at least 8 quarter hours of graduate credit must be earned outside of Mechanical Engineering and Materials Science. Officers specializing in Materials Science must also have at least two ME4000 level courses in addition to those cited above.

An acceptable thesis is required for the Master of Science in Mechanical Engineering degree. An acceptable thesis for the degree of Mechanical Engineer may also be accepted as meeting the thesis requirement for the master's degree. Approval of the thesis advisor and topic must be obtained from the Chairman of the Department of Mechanical Engineering.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students with acceptable academic backgrounds may enter a program leading to the degree Master of Science in Engineering Science (with major in Mechanical Engineering).

The program must include at least 36 credit hours of graduate work in the disciplines of engineering, science and mathematics, 12 of which must be at the 4000 level. Of those 36 hours, at least 20 hours (eight of which must be at the 4000 level) must be in Mechanical Engineering and Materials Science.

In addition, the program must contain at least 12 hours at the graduate level in courses outside Mechanical Engineering and Materials Science.

The student seeking the degree Master of Science in Engineering Science must submit an acceptable thesis. Programs leading to this degree must be approved by the Chairman of the Department of Mechanical Engineering.

MECHANICAL ENGINEER

A graduate student with a superior academic record (with a graduate QPR of 3.70 or better) may enter a program leading to the degree Mechanical Engineer. A candidate is normally selected after completion of his first year of residence.

A candidate must take all courses in a curriculum approved by the Chairman of the Department of Mechanical Engineering. At minimum, the approved curriculum must satisfy the requirements stated in the following paragraphs.

The Mechanical Engineer degree requires at least 60 quarter hours of graduate level credits in Mechanical Engineering and Materials Science, at least 30 of which must be at the 4000 level. In addition, at least 12 quarter hours of graduate level credits must be earned outside of Mechanical Engineering and Materials Science.

An acceptable thesis is required for the Mechanical Engineer degree. Approval of the thesis advisor and program must be obtained from the Chairman of the Department of Mechanical Engineering.

TOTAL SHIP SYSTEMS ENGINEERING PROGRAM

A Mechanical Engineer degree may also be obtained as part of the Total Ship Systems Engineering program. The program objective is to provide a broad-based design-oriented education focusing on the warship as a total engineering system. Entry requirements are a baccualaureate degree in an engineering discipline with an APC of 222 and students are expected to validate several courses in the standard MSME degree program. A thesis is required that may address system design issues. The advisor and topic must have prior approval of the Chairman of the Mechanical Engineering Department.

DOCTOR OF PHILOSOPHY AND DOCTOR OF ENGINEERING

The Department of Mechanical Engineering has an active program leading to the degrees of Doctor of Philosophy and Doctor of Engineering. Areas of special strength in the department are hydrodynamics, viscous flows, heat transfer, materials science, dynamics and control, vibrations and finite element analysis and computer aided design.

Entrance into the doctoral program may be requested by officers currently enrolled who have sufficiently high standing. A departmental screening examination will be administered to those so requesting. The department also accepts officer students selected in the Navy-wide doctoral study program and civilian students selected from employees of the United States Federal Government.

All applicants who are not already enrolled as students in the Department of Mechanical Engineering shall submit transcripts of their previous academic and professional records and letters of recommendation to the department Chairman. The Chairman, with the advice of other department members, shall decide whether or not to admit the applicant to the doctoral program.

Every applicant who is accepted for the doctoral program will initially be enrolled in the Mechanical Engineering Program under a special option which satisfies the broad departmental requirements for the Engineer's degree and which includes research work. As soon as feasible, the student must find a faculty advisor to supervise research and help initially in the formulation of plans for advanced study. As early as practicable thereafter, a doctoral committee shall be appointed to oversee that student's individual doctoral program as provided in the school-wide requirements for the doctor's degree.

Joint programs with other departments are possible. A noteworthy feature of the program leading to the Doctor of Engineering degree is that the student's research may be conducted away from the Naval Postgraduate School in a cooperating laboratory or other installations of the Federal Government. The degree requirements are as outlined in the general school requirements for the doctor's degree.

LABORATORIES

The Mechanical Engineering Laboratories are designed as complements to the educational mission and research interests of the department. In addition to extensive facilities for the support of student and faculty research, a variety of general use equipment is available. This includes machinery for the investigation of dynamic and statistics problems in engineering mechanics; a completely equipped materials science laboratory, including a scanning electron microscope, a transmission electron microscope and an X-ray diffractometer; an oscillating water tunnel, a unique underwater towing tank and a low turbulence water channel; a vibration analysis laboratory; a fluid power controls laboratory; a robotics and real-time control laboratory; facilities for experimentation with low velocity air flows; equipment for instruction in thermal transport phenomena; a laser doppler velocimeter; nuclear radiation detection equipment and an interactive CAD/CAE computer graphics laboratory. Experimentation is further enhanced by a broad selection of analog and digital data acquisition and processing equipment and instrumentation.

COURSE OFFERINGS

ME0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

ME0951 SEMINARS (NO CREDIT) (0-1).
Lectures on subjects of current interest are presented by NPS faculty and invited experts from other universities and government and industrial activities.

ME1000 PREPARATION FOR PROFESSIONAL ENGINEERS REGISTRATION (3-0).
The course will cover the topics from the 8 hour Professional Examination given by the State of California for Professional Engineers. Discussion will involve applicable engineering techniques, including design and analysis of mechanical systems and components. PREREQUISITE: Prior passage of EIT Exam or consent of instructor. Graded on Pass/Fail basis only.

ME2001 INTRODUCTION TO ENGINEERING (3-0).
The origins of engineering. The role of mathematics and the physical sciences in engineering. Definition of an engineering problem, including its formulation, assumptions and method of attack. Engineering analysis. The engineering design process. Engineering communications, including graphics. This course is intended for students with a non-engineering background. PREREQUISITE: MA1117 (may be taken concurrently).

ME2101 ENGINEERING THERMODYNAMICS (4-1).
A comprehensive coverage of the fundamental concepts of classical thermodynamics, with insight toward microscopic phenomena. The laws of thermodynamics. Equations of state. Thermodynamic properties of substances. Entropy, irreversibility and availability. Cycle analysis. Gas-vapor mixtures. Combustion and dissociation. PREREQUISITE: MA1118.

ME2201 INTRODUCTION TO FLUID MECHANICS (3-2).
Properties of fluids, hydrostatics and stability of floating and submerged bodies. Fluid flow concepts and basic equations in steady flows: mass, momentum and energy considerations. Dimensional analysis and dynamic similitude. Viscous effects and fluid resistance. Drag and separated flow over simple bluff bodies. PREREQUISITE: ME2502.

ME2301 INTRODUCTION TO NAVAL ARCHITECTURE (3-1).
Introduction to the hydrostatics and hydrodynamics of a monohull vessel. Hull structural strength using simple approximations and common ship building materials. Intact initial

transverse and longitudinal stability. Stability at large angles of heel and under special circumstances such as docking and after damage to the hull. Resistance and powering of the hull; determination of effective horsepower. PREREQUISITES: ME2201 and ME2601.

ME2440 THE DIGITAL COMPUTER AS AN ENGINEERING TOOL (3-0).
Introduction to high-level programming languages including FORTRAN and BASIC. Development of computer programs, subroutine organization, input and output. Application of programming techniques to the solution of selected problems in Mechanical Engineering. PREREQUISITES: MA1118, ME2101, ME2501 (all may be taken concurrently), ME2441 (must be taken concurrently).

ME2441 ENGINEERING COMPUTATIONAL LABORATORY (0-2).
Introduction to the computing facilities at the Naval Postgraduate School with particular emphasis on those unique to the Department of Mechanical Engineering. Familiarization with software available at the Naval Postgraduate School for solution of engineering problems. Various programming exercises. (ME2440 must be taken concurrently). Graded on a Pass/Fail basis only.

ME2501 STATICS (3-0).
Forces and moments, particles and rigid bodies in equilibrium. Simple structures, friction, first moments and centroids. PREREQUISITE: MA1118 (may be concurrent).

ME2502 DYNAMICS (4-1).
Kinematics and kinetics of particles and rigid bodies. Rectilinear, plane curvilinear and space curvilinear motion. Newton's laws, work and energy, impulse and momentum and impact. Plane motion of rigid bodies and introduction to gyroscopic motion. PREREQUISITE: ME2501.

ME2601 MECHANICS OF SOLIDS I (3-2).
Stress-strain. Hookes Law. Plane stress and plane strain. Stress transformation for plane stress. Mohr's circle. Principal stresses and axes. Stress analysis of bars, circular shafts, cylindrical and spherical thin walled pressure vessels. Shear and bending diagrams for beams. Stresses in beams. Failure theories. Torsion of thin walled closed tubes. Composite beams. Euler columns. Supporting laboratory work. PREREQUISITES: ME2501 and MA1118 or equivalent.

ME2801 INTRODUCTION TO ENGINEERING SYSTEM DYNAMICS (3-2).
Generalized system modeling principles and reduction to mathematical forms. Analogies between electrical, mechanical, fluid and thermal systems. Response of first and second order systems characteristics, transient response. PREREQUISITES: ME2502 and MA2121.

ME3150 HEAT TRANSFER (4-2).
Introduction to the various modes of heat transfer and their engineering applications. Steady and unsteady conduction involving the use of thermal circuit analogs, analytical, finite difference and graphical techniques. Introduction to conservation of mass, momentum and energy. External and internal forced convection fundamentals and correlations. External natural convection. Boiling. Condensation. Heat exchanger analysis. Thermal radiation. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3201 INTERMEDIATE FLUID MECHANICS (3-2).
Steady one-dimensional compressible flow. Fundamentals of ideal-fluid flow, potential function, stream function. Analysis of viscous flows, velocity distribution in laminar and turbulent flows, introduction to the elements of the Navier-Stokes equations, solution of classical viscous laminar flow problems. Boundary layer concepts. PREREQUISITES: ME2101, ME2201, MA3132 (may be taken concurrently).

ME3220 STEAM POWER, REFRIGERATION AND TURBOMACHINERY (3-2).
The conventional Rankine cycle steam plants, including superheat, reheat and

regenerative cycles. Boiler, condenser and feed-water heater description. Thermodynamics of refrigeration systems. Fundamentals of turbomachinery: energy and momentum equations, dimensional analysis and velocity diagrams. Blade design and work determination from blade shape. Application to pumps, fans, compressors and turbines. PREREQUISITES: ME2101 and ME2201.

ME3230 NUCLEAR POWER SYSTEMS (3-1).
Introduction to atomic and nuclear physics. Fundamentals of nuclear reactor analysis, including nuclear and thermal aspects in core design. Reactor system design and operation. Comparison of principal reactor types emphasizing significant features of marine reactors. Basic health physics considerations and reactor shielding. Basic insight into waste management and reactor safety. PREREQUISITE: MA3132.

ME3240 RECIPROCATING AND GAS TURBINE POWER PLANTS (3-0).
Thermodynamic analysis and performance characteristics of single and multi-stage reciprocating air compressors, spark ignition engines (Otto Cycle), compression ignition engines (diesel cycle) and gas turbine engines (Brayton cycle). Gas turbine component characteristics including the aerodynamics of the compressor and turbine design and the combuster. Ship propulsion requirements, propeller characteristics and Ship/Propeller/ Power Plant matching. PREREQUISITES: ME2101, ME2201, (ME3241 must be taken concurrently).

ME3241 POWER PLANTS LABORATORY (0-3).
Selected experiments demonstrating power plant performance, e.g., diesel engine and gas turbine engine. (ME3240 must be taken concurrently.) Graded on Pass/Fail basis only.

ME3410 MECHANICAL ENGINEERING INSTRUMENTATION AND MEASUREMENT LAB (2-4).
Introduction to measurement systems, statistical analysis of data, error analysis, uncertainty analysis, manipulation of data including electrical readout and processing, data acquisition fundamentals. Measurement of temperature, pressure, velocity, flow rates. Energy balances, surface temperature visualization, flow visualization. Measurement of motion using accelerometers and encoders. Measurement of strain and force. Operational amplifiers, analog computers, filters. PREREQUISITES: ME2601, ME2801, ME3521, ME3150 (ME3150 and ME3521 may be taken concurrently).

ME3440 ENGINEERING ANALYSIS (4-0).
Rigorous formulation of engineering problems arising in a variety of disciplines. Approximate methods of solution. Finite Difference methods. Introduction to finite Element methods. PREREQUISITES: ME2201, ME2440, ME2502 and ME2601.

ME3521 MECHANICAL VIBRATION (3-2).
Free and forced vibration of discrete linear systems. Vibration isolation and suppression. Vibration of bars, shafts and beams. Supporting laboratory work. PREREQUISITES: ME2502, ME2601 and MA2401 or equivalent (may be taken concurrently).

ME3611 MECHANICS OF SOLIDS II (4-0).
Differential equations of bars, shafts and beams with Macauley functions. Unsymmetric bending. Curved beams. Shear flow in thin walled sections. Shear center. Torsion of thin walled open sections. Thick walled cylinders. Energy including Castigliano and unit dummy load methods for displacements. Statically indeterminate systems including beams, frames, trusses, arches and combined structures. PREREQUISITE: MA2047 or MA2089

ME3711 DESIGN OF MACHINE ELEMENTS (4-1).
Design of representative machine elements with consideration given to materials selection, tolerances, stress concentrations, fatigue, factors of safety, reliability and maintainability. Typical elements to be designed include fastener, columns, shafts, journal bearings, spur and helical gears and clutches and brakes. In addition to traditional design using factors of

safety against failure, particular emphasis is placed on design for specified reliability using probabilistic design methods. PREREQUISITE: ME2601.

ME3801 LINEAR AUTOMATIC CONTROL (3-0).
Classical control design for linear systems with single input, single output design requirements. PID control. Transient response analysis. Root locus and frequency response methods. Control design and compensation techniques. PREREQUISITE: ME2801. ME3802 must be taken concurrently.

ME3802 CONTROLS LABORATORY (0-2).
Adjunct laboratory for ME3801. Must be taken concurrently with ME3801.

ME3950 SURFACE SHIP SURVIVABILITY (4-0).
Surface ship survivability requirements and lessons learned in combat; radar cross section reduction by shaping and RAM; IR missile detection and tracking; electronic counter measures for decoying and jamming missiles. Assessment of ship survivability and implementation of trade-off studies. Case study of DDG-51 survivability design. PREREQUISITES: Consent of instructor and department Chairman.

ME4160 APPLICATIONS OF HEAT TRANSFER (4-0).
Applications of heat transfer principles to engineering systems. Topics include heat exchangers (e.g., boilers, condensers, coolers), cooling electronic components, heat pipes, solar collectors, turbine blade cooling. PREREQUISITE: ME3150.

ME4161 CONDUCTION HEAT TRANSFER (4-0).
Steady-state heat conduction in multi-dimensions with and without heat sources. Transient conduction. Numerical methods for heat conduction. Mechanical Engineering applications. PREREQUISITE: ME3150.

ME4162 CONVECTION HEAT TRANSFER (4-0).
Fundamental principles of forced and free convection. Laminar and turbulent duct flows and external flows. Dimensionless correlations. Heat transfer during phase changes. Heat exchanger analysis with Mechanical Engineering applications. PREREQUISITES: ME3150, ME4220.

ME4163 RADIATION HEAT TRANSFER (3-0).
Basic laws and definitions. Radiation properties of surfaces. Radiant interchange among diffusely emitting and reflecting surfaces. Applications and solutions of the equations of radiant interchange. Radiant interchange through participating media. Combined conduction and radiation. PREREQUISITE: ME3150.

ME4202 COMPRESSIBLE FLOW (3-0).
Review of simple one-dimensional flow. Generalized one-dimensional flow. Two-dimensional and axisymmetric flows. Subsonic flow with small perturbations. Mach lines. Methods of characteristics. Prandtl-Meyer expansion waves. Oblique shocks. Unsteady, one-dimensional flow. Introduction to compressible boundary layer. PREREQUISITE: ME3201 or equivalent compressible flow coverage.

ME4211 APPLIED HYDRODYNAMICS (4-0).
Fundamental principles of hydrodynamics. Brief review of the equations of motion and types of fluid motion. Standard potential flows: source, sink, doublet and vortex motion. Flow about two-dimensional bodies. Flow about axisymmetric bodies. Added mass of various bodies and the added-mass moment of inertia. Complex variables approach to flow about two-dimensional bodies. Conformal transformations. Flow about hydro and aerofoils. Special topics such as dynamic response of submerged bodies, hydroelastic oscillations, etc. Course emphasizes the use of various numerical techniques and the relationship between the predictions of hydrodynamics and viscous flow methods. PREREQUISITE: ME3201.

ME4220 VISCOUS FLOW (4-0).
Development of continuity and Navier-Stokes equations. Exact solutions of steady and unsteady viscous flow problems. Development of the boundary-layer equations. Similarity variables, numerical and integral techniques. Separation, boundary-layer control,

compressibility effects. Time-dependent boundary layers. Origin and nature of turbulence, phenomenological theories, calculation of turbulent flows with emphasis on naval engineering applications. PREREQUISITE: ME3201.

ME4240 ADVANCED TOPICS IN FLUID DYNAMICS (4-0).
Topics selected in accordance with the current interests of the students and faculty. Examples include fluid-structure interactions, cable strumming, wave forces on structures, free-streamline analysis of jets, wakes and cavities. PREREQUISITES: ME4220 and ME4211.

ME4420 MARINE GAS TURBINES (4-0).
Thermodynamic analyses of gas turbine cycles, including airbreathing and closed cycle engines. Internal aerodynamics of compressor and turbine design. Combustor and source heat exchanger design. Materials considerations. Operational controls and instrumentation. Lubrication and fuels systems. Inlet, exhaust and silencing systems. Propulsion of surface effect, hydrofoil and conventional surface ships. Installation arrangements. Waste heat recovery systems and combined cycles (COGAS, CODOG). Auxiliary power generation. Repair and maintenance. PREREQUISITE: ME3240.

ME4522 SHIPBOARD VIBRATION AND NOISE (4-0).
Mechanical impedance, transfer matrices and their application to transmission of vibratory motion from machinery sources to hull plating. Acoustic signal generation at the hull-fluid interface. Characteristics of viscoelastic materials and their use in vibration isolation. Multi-isolator mounts. Study of accordian and flexural vibration of ship hulls using one-dimensional finite element modeling. Military vibration specifications. Use of vibration measurements for machinery condition monitoring. PREREQUISITE: ME3521.

ME4525 NAVAL SHIP SHOCK DESIGN AND ANALYSIS (4-0).
Characteristics of underwater explosion phenomena, including the shock wave, bubble behavior and bubble pulse loading and bulk cavitation. Surface ship/submarine bodily response to shock loading. Application of shock spectra to component design. Dynamic Design Analysis Method (DDAM) and applications to shipboard equipment design. Fluid-Structure Interaction (FSI) analysis, including Doubly Asymptotic Approximation (DAA) and surface ship FSI. Current design requirements for shipboard equipment. PREREQUISITE: ME3521 or equivalent.

ME4550 RANDOM VIBRATIONS AND SPECTRAL ANALYSIS (3-2).
Engineering application of spectral analysis techniques to characterize system responses under a random vibration environment. Characteristics of physical random data and physical system responses. Application of probability concepts to random data and response analysis. Correlation and spectral density functions. Transmission of random vibration. System responses to single/multiple random excitations. Failure due to random vibration. Supporting laboratory work. PREREQUISITE: ME3521 or equivalent.

ME4612 ADVANCED MECHANICS OF SOLIDS (4-0).
Selected topics from advanced strength of materials, elasticity and the theory of plates and shells. Applications of finite element codes to the solution of difficult problems. PREREQUISITE: ME3611.

ME4613 FINITE ELEMENT METHODS (4-0).
Systematic construction of line, surface and volume elements for continuous systems. Computer programming and applications to structural mechanics, heat transfer and fluid flow. PREREQUISITE: ME3611.

ME4620 THEORY OF CONTINUOUS MEDIA (4-0).
Tensor analysis. Stress and strain tensors. Motion of continuum. Energy and entropy. Constitutive equations. Applications to elasticity and fluid dynamics. PREREQUISITES: ME3201 and ME3611.

ME4721 MARINE VEHICLE DESIGN (2-4).
Various categories of marine vehicles are described; this includes single hull, multiple hull,

submarine, surface effect, wing-in-ground effect and hydrofoil vehicles. A category of marine vehicle is selected to fulfill a stated mission. A vehicle configuration and specification of major facets of marine vehicle synthesis including structures, hull forces, propulsion, electronics, armament, crew, etc. PREREQUISITE: Consent of instructor.

ME4722 MARINE ENGINEERING DESIGN (2-4).
A major component of a marine vehicle is designed so as to meet stated specifications. Impact of the design features of the major component upon the overall vehicle performance is considered; emphasis is on design tradeoffs. Examples of major components to be designed include complete electrical power generation and distribution systems, steering, superconducting electrical motors for main propulsion, bulbous bow for sonar, armor protection of CIC, etc. PREREQUISITE: Consent of instructor.

ME4731 ENGINEERING DESIGN OPTIMIZATION (4-0).
Application of automated numerical optimization techniques to design of engineering systems. Algorithms for solution of nonlinear constrained design problems. Familiarization with available design optimization programs. State-of-the-art applications. Solution of a variety of design problems in mechanical engineering, using numerical optimization techniques. PREREQUISITES: ME3150, ME3201, ME3611, ME2440, MA2400, or equivalent.

ME4811 MODERN CONTROL SYSTEMS (3-2).
Multivariable analysis and control concepts for MIMO systems. State Observers. Linear Optimal Control. Introduction to non-linear systems analysis. Limit cycle behavior. PREREQUISITE: ME3801.

ME4812 FLUID POWER CONTROL (3-0).
Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements - valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability. ME4813 must be taken concurrently. PREREQUISITE: ME3801.

ME4813 FLUID POWER LABORATORY (0-2).
Adjunct laboratory course for ME4812. Must be taken concurrently with ME4812.

ME4821 ADVANCED DYNAMICS (3-2).
Introduction to the variational principle. Kinematics and dynamics of three-dimensional motion for complex systems utilizing Newton-Euler's method, Lagrange's method and Kane's method. Computer software implementation and simulation. Applications in robotics emphasizing the dynamic problems of design and control. PREREQUISITE: ME3521.

ME4823 DYNAMICS OF MARINE VEHICLES (4-0).
Development of the nonlinear equations of motion in ship-fixed coordinates. Linear forms. Elements of pathkeeping and stability for ships and submersibles. Maneuverability. Hydrodynamic aspects of hull propulsor and appurtenances. Design tools for estimating hydrodynamic derivatives and their effects on vehicle performance. Selected topics. PREREQUISITE: ME3201.

ME4825 MARINE PROPULSION CONTROL (3-2).
Introduction to dynamic propulsion systems modeling and analysis methods. Control design specifications and design strategies. Introduction to modern control design theory and multivariable methods. Theory and applications of optimal control and discrete-time control systems. Case studies of current Naval propulsion control systems. PREREQUISITES: ME3801, ME3240 (may be taken concurrently) and MA3132.

ME4902 ADVANCED STUDY IN MECHANICAL ENGINEERING (Variable hours 1-0 to 6-0) (V-0).
Directed advanced study in mechanical engineering on a subject of mutual interest to student and staff member after most of a student's electives have already been taken. May

be repeated for credit with a different topic. PREREQUISITE: Permission of department Chairman. Graded on Pass/Fail basis only.

MS0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

MS2201 ENGINEERING MATERIALS (3-2).
The basic principles of materials science are covered with emphasis on the factors involved in control of the strength and ductility of metallic materials of Naval interest. Atomic and crystal structure are discussed and emphasis is given to microstructural control and microstructure-property relationships. Additional topics include crystalline defects, deformation processes, strengthening mechanisms and heat treatment. The course aims to provide the student with the working vocabulary and conceptual understanding necessary for more advanced study and for communication with materials experts. PREREQUISITES: Undergraduate courses in physics and chemistry and consent of instructor.

MS3202 FAILURE ANALYSIS AND PREVENTION (3-2).
Properties, problems and failures of structural materials are studied in the context of actual case studies. Topics of interest to Naval, Aero and Weapons engineers are included. For a given case study, the cause(s) of failure are discussed and the relevant fundamental knowledge to fully understand the observed phenomena is developed. Failure prevention, materials developments and modern methods of materials analysis are among the many aspects that are of interest. PREREQUISITE: MS3201 or equivalent or consent of instructor.

MS3304 CORROSION AND MARINE ENVIRONMENTAL DEGRADATION (3-2).
Presents the basic chemical, electrochemical, mechanical and metallurgical factors which influence the corrosion, oxidation and deterioration of materials. Discusses standard methods of corrosion control, such as cathodic protection coatings, cladding, alloy selection and inhibitors; special problems encountered in unfamiliar environment. PREREQUISITE: MS2201 or equivalent.

MS3401 MICROSCOPY (3-2).
Electron microscopy and other sophisticated techniques are emphasized in a coverage of modern methods of microscopic observation. Techniques covered include scanning electron microscopy, transmission electron microscopy, conventional microprobe analysis, field ion microscopy and polarized light, stereo, interference, phase contrast and holographic light optical methods. Course and lab will simultaneously cover both theory and practice, including specimen preparation, instrument design and operation and applications. PREREQUISITE: Consent of instructor.

MS3505 MATERIALS SELECTION FOR MILITARY APPLICATIONS (4-0).
This course deals in-depth with one of the most common and important problems in materials engineering, that of selecting the optimum material for a given application. Consideration is also given to evolution of new applications for existing materials and to materials development for new and old applications. A variety of application areas are covered, including marine structures, aerospace applications, nuclear reactors, electronics, high temperature cryogenic services and many other situations. Sources of information, methodology and basic rationale for materials selection decisions are presented. Emphasis is put on the variation in properties of a given material with processing history and on variation of properties in service. PREREQUISITE: MS2201 or equivalent.

MS3606 INTRODUCTION TO WELDING AND JOINING METALLURGY (3-2).
Welding and joining are presented from the point of view of metallurgy. Topics include the nature and applications of welding and joining processes; the welding thermal cycle; metallurgical effects of the welding thermal cycle; welding and joining of steels, aluminum alloys, stainless steels and heat resistant alloys. Also, weldment inspection and quality assurance are introduced. PREREQUISITES: MS2201/MS3201.

MS4215 PHASE TRANSFORMATIONS (3-2).
Structural changes which commonly occur in materials by various mechanisms are considered. Solidification, precipitation, recrystallization and martensitic transformations are emphasized, both in principle and in regard to their technological importance. Principles of nucleation and growth, diffusion and kinetics are presented and their relevance to practical heat treating and fabrication processes are considered. PREREQUISITE: MS2201 or equivalent.

MS4302 SPECIAL TOPICS IN MATERIALS SCIENCE (Variable hours 1-0 to 6-0). (V-0).
Directed advanced study in materials science on a subject of mutual interest to student and staff member after the student has taken most of his or her electives. May be repeated for credit with a different topic. PREREQUISITE: Permission of department Chairman. Graded on Pass/Fail basis only.

MS4312 ADVANCED MATERIALS (4-0).
The course is structured to provide a vehicle for the study of materials pertinent to a specific area of environment utilization or design. Example categories are marine materials, elevated-temperature materials, aircraft alloy materials for energy conversion. Topics discussed may include material failures, materials selection testing and new concepts in materials engineering. Course scope is decided by mutual agreement of students and instructor. PREREQUISITES: MS2201, MS3202 or equivalent.

MS4811 MECHANICAL BEHAVIOR OF ENGINEERING MATERIALS (4-0).
The response of structural materials to mechanical stress is discussed with emphasis on plastic deformation in metals. Topics include elastic response and the modulus of elasticity; plasticity; deformation mechanisms and dislocation theory; strengthening mechanisms; and fatigue and fracture. Application of subject to materials development is also considered. PREREQUISITE: MS3202 or permission of instructor.

MS4822 THE ENGINEERING AND SCIENCE OF COMPOSITE MATERIALS (4-0).
This course focusses on the structure-property correlation in composites utilitzing a multi-disciplinary approach, covering the areas of materials science and engineering and solid mechanics. Emphasis is given to the theoretical constitutive behavior at the micro- and macro-levels, as well as on how such behavior can be altered by processing and service variables. The course is divided into three broad parts: (1) Theoretical predictions of composite properties; (2) Materials issues (including processing) complicating accurate performance prediction; and (3) Thermo-mechanical behavior in actual service coniditons. PREREQUISITES: ME3611, MS3202 or equivalent.

TS3000 ELECTRICAL POWER ENGINEERING (3-2).
An overview of the principles, concepts and trade-offs which form the foundation for shipboard electric power systems. The composition of electrical power systems for present and future Navy vessels is presented. Theory necessary to understand interactions among shipboard electric power system components is discussed. The interactions between the electric power system and the various types of loads is introduced. PREREQUISITE: EC2270 or EC2110.

TS3001 FUNDAMENTAL PRINCIPLES OF NAVAL ARCHITECTURE (3-2).
The geometry, hydrostatics and hydrodynamics of monohull and other floating and submerged bodies; Froude similarity; wave and skin friction resistance; powering determination. Longitudinal and transverse stability of floating bodies. Hull girder strength. Introduction to seakeeping and passive survivability principles. PREREQUISITES: ME2201 and ME2601.

TS3002 PRINCIPLES OF SHIP DESIGN AND CASE STUDIES (3-2).
Systems engineering in the design of complex systems; systems architecture and interface engineering and the Navy design environment. The systems development process, including need identification, requirements, feasibility determination, risk reduction,

contract and detailed design. The iterative, multi-level ship design process, with affordability as a fundamental feature; modern ship design and construction methods. Case studies, ship design trends, design exercises and illustrative problems. PREREQUISITE: TS3001.

TS3003 NAVAL COMBAT SYSTEM ELEMENTS (3-2).
This course will cover combat system detection and engagement elements. This includes radar, ESM, active and passive sonar, infrared, warheads, guns, missiles, torpedoes, fire control and countermeasures. The emphasis will be on what the elements contribute to a combat system, their basic principles of operation, their performance limitations, and their interfaces with the rest of the combat system. Details on the internal functioning of specific elements will be limited to illustrating applications of basic principles and interactions affecting system engineering. PREREQUISITES: MA2049, ME2502, EC2170 or equivalent. SECRET clearance.

TS4000 NAVAL COMBAT SYSTEM ENGINEERING (3-2).
This course will cover the definition and integration of Naval combat systems. The emphasis will be on how the various detection, engagement, and control elements interact with each other and on how to combine them into an efficient and survivable combat system. Also addressed will be topside arrangements, signature reduction, readiness assessment, embedded training, real time computer programs, and support system interfaces. Details on specific elements and systems will be limited to those needed to illustrate basic principles and methods. PREREQUISITES: TS3003, TS3000. SECRET clearance.

TS4001 INTEGRATION OF NAVAL ENGINEERING SYSTEMS (4-1).
A systems-oriented approach to integrating the principles of Naval Architecture, Marine Engineering and Materials Engineering in the design of mechanical ship subsystems. Lectures and projects exploring engineering design tools and project management techniques used to meet specified systems requirements. Materials issues affecting ship design. Group projects on hull, mechanical and electrical ship systems design. The impact of systems design on other systems and subsystems, including affordability and survivability at the whole ship level are considered. PREREQUISITES: TS3000, TS3002, MS3201.

TS4002 SHIP DESIGN INTEGRATION (2-4).
The ship impact of requirements/cost/performance trade offs within technical and acquisition constraints. Conversion of broad military requirements to mission-based ship requirements and specific tasks resulting from those requirements. Exploration of alternative methods of satisfying requirements, leading to combat systems (payload) definition. Conduct of feasibility studies to investigate whole-ship alternatives which meet requirements. Selection of a best design approach. Special design aspects of, aircraft carriers and variable payload ships. Design considerations for unusual ship types and an assessment of future Navy ship and combat systems needs and trends. PREREQUISITES: TS4001 and TS4000. SECRET clearance.

TS4003 TOTAL SHIP SYSTEMS ENGINEERING (2-4).
The design of a Naval vessel as a single engineering system satisfying mission requirements, with emphasis on affordability and survivability. The interaction and interfacing of various subsystems such as hull, propulsion and combats systems will be explored through a joint ship "preliminary design" project to produce a balanced ship design based on the alternative chosen from feasibility studies conducted in TS4002. Concepts of design optimization within constraints. PREREQUISITES: TS4002 and SECRET clearance

DEPARTMENT OF METEOROLOGY

Lester E. Carr, Lieutenant Commander, U.S. Navy; Assistant Professor (1992)*; PhD, Naval Postgraduate School, 1989.

Chih-Pei Chang, Professor (1972)*; PhD, University of Washington, 1972.

Jeng-Ming Chen, Adjunct Research Professor (1989); PhD, University of California at Los Angeles, 1989.

Kenneth L. Davidson, Professor (1970); PhD, University of Michigan, 1970.

Philip A. Durkee, Associate Professor (1984); PhD, Colorado State University, 1984.

Russell L. Elsberry, Professor (1968); PhD, Colorado State University, 1968.

George W. Haltiner, Distinguished Professor Emeritus (1946); PhD, University of Wisconsin, 1948.

Robert L. Haney, Chairman and Professor (1970); PhD, University of California at Los Angeles, 1971.

Patrick A. Harr, Adjunct Research Professor (1989); MS, Colorado State University, 1978.

Paul A. Hirschberg, Adjunct Research Professor (1990); PhD, Pennsylvania State University, 1989.

Teddy R. Holt, Assistant Professor (1989); PhD, North Carolina State University, 1989.

Frank L. Martin, Professor Emeritus (1947); PhD, University of Chicago, 1941.

James T. Murphree, Adjunct Research Professor (1991); PhD, University of California at Davis, 1989.

Wendell A. Nuss, Assistant Professor (1986); PhD, University of Washington, 1986.

Patricia A. Pauley, Adjunct Professor (1990); PhD, Purdue University, 1985.

Melinda S. Peng, Adjunct Research Professor (1984); PhD, State University of New York at Albany, 1982.

Robert J. Renard, Distinguished Professor Emeritus (1952); PhD, Florida State University, 1970.

Willem van der Bijl, Professor Emeritus (1961); PhD, State University, Utrecht, 1952.

Carlyle H. Wash, Professor (1980); PhD, University of Wisconsin, 1978.

Forrest R. Williams, Adjunct Professor (1983); MS, Massachusetts Institute of Technology, 1972.

Chairman:
Robert L. Haney
Professor
Code MR/Hy, Root Hall
Room 252
(408) 656-2517
DSN 878-2517

Associate Chairmen:

Research
Kenneth L. Davidson
Professor
Code MR/Ds, Root Hall
Room 244
(408) 656-2309
DSN 878-2309

Curricular Matters
Roger T. Williams
Professor
Code MR/Wu, Root Hall
Room 247
(408) 656-2296
DSN 878-2296

Roger T. Williams, Professor (1968); PhD, University of California at Los Angeles, 1963.

Tren-Chiang Yeh, Adjunct Research Instructor (1990); MS, National Central University (Taiwan), 1979.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of Meteorology is one of eleven departments and its history dates back to the 1940s when it was part of the Postgraduate Department at the Naval Academy. The department's academic function is interdisciplinary in nature in that it supports separate Master of Science Degree programs: Meteorology, Meteorology and Oceanography, and Oceanography; and, provides courses for the Space, Antisubmarine Warfare, Electronic Warfare, and Command, Control and Communications (C3) curricula.

Department academic strengths include air/ocean dynamics and numerical modeling and prediction, structure and dynamics of the atmospheric boundary layer, satellite remote sensing and its applications and synoptic meteorology, including analysis and prediction in tropical, middle latitude and polar regions in both hemispheres. More than forty courses are offered in meteorology, primarily at the graduate level. The department has twelve teaching faculty and six adjunct research faculty, with graduate student participation as research-team members through the MS thesis and Ph.D. dissertation process. The current areas of research concentration encompass numerical and analytic air/ocean modeling and numerical weather prediction, tropical meteorology, including monsoon circulations and tropical cyclone forecasting, coastal meteorology, climate dynamics, marine boundary layer studies with emphasis on air/sea interactions and electromagnetic/optic propagation, remote sensing/satellite meteorology and a wide range of synoptic studies (e.g., regional studies, maritime cyclogenesis, short range forecasting, numerical-model output verification).

Both Visiting Scientist and Navy-sponsored Research Chair programs are an integral part of the department's operation. The Ph.D. program in the department is active with Navy Officers, Air Force Officers, DoD civilians and internationals among its recent graduates.

DEPARTMENT REQUIREMENTS FOR DEGREES

MASTER OF SCIENCE IN METEOROLOGY

Entrance to a program leading to a Master of Science degree in Meteorology requires a baccalaureate degree with completion of mathematics through differential and integral calculus and a minimum of one year of college physics.

The degree Master of Science in Meteorology requires completion of:

1) Necessary prerequisite courses in mathematics (through partial differential equations) and meteorology,

2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology,

3) An approved selection of graduate elective courses,

4) An acceptable thesis.

The total number of quarter hours in (2) and (3) above must be at least 36. These 36 hours must include 18 quarter hours at the 4000 level in courses other than directed study.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics or engineering. This normally permits the validation of a number of required

undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree Master of Science in Meteorology and Physical Oceanography requires completion of:

1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography,

2) The sequence of core courses in the fields of dynamical, numerical, physical and synoptic meteorology and oceanography,

3) An approved selection of graduate elective courses in meteorology and oceanography,

4) An acceptable thesis on a topic approved by either department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of meteorology and physical oceanography.

DOCTOR OF PHILOSOPHY

The Ph.D. program is offered in the Department of Meteorology in the following areas of study: numerical weather prediction, geophysical fluid dynamics, boundary-layer meteorology, analysis of atmospheric systems and tropical meteorology.

The requirements for the degree are grouped into three categories: course work, research in conjunction with an approved dissertation and examination in both the major and a minor field. The minor field is usually in physical oceanography, mathematics or physics.

The Department of Meteorology also may require a preliminary examination to show evidence of acceptability as a doctoral student.

Prospective students should consult with the Chairman of the Department of Meteorology for further guidance regarding doctoral programs.

LABORATORIES

In addition to the standard synoptic laboratories, NPS meteorological facilities include the Meteorology/Oceanography Interactive Digital Environmental Analysis Laboratory which provides real-time acquisition and analysis of conventional and remotely-sensed data in support of the synoptic and physical meteorology programs. The laboratory consists of 17 image analysis and graphics workstations hosted by a number of VAX computers with two tape drives and greater than six gigabytes of disc storage. In FY 92-93 the laboratory is being upgraded to a system of UNIX based workstations.

The department has also completed the installation of its new Marine Atmospheric Measurements Laboratory. This facility features state-of-the-art instrumentation for calibration work and for probing the atmosphere with both in situ and remote sensing devices. The laboratory features a 404.37 MHz doppler radar wind profiler (a 915 MHz profiler is on order in FY93), a Vaisala rawinsonde system with both Omega and LORAN-C navigational aids and a controlled temperature/humidity chamber which operates to -10 C while controlling humidity in the range of 5-98%.

The department has a variety of instruments for observing the atmosphere and equipment for receiving weather analyses and forecasts emanating from the National Weather Service, including the DIFAX facsimile network system, the COMEDS link to the Automated Weather Network and a RADAC Weather Radar Receiver, a real-time link to

the nationwide weather radar network. Additional information is received from Fleet Numerical Oceanography Center via the Navy Oceanographic Data Distribution System (NODDS). Weather satellite data are received on a UNIFAX recorder via GOESTAP and displayed in animated form by the Digital Weather Image Processing System. Rawinsonde equipment, acoustic sounders and micrometeorologically instrumented masts and an NSF-owned Research Vessel operated by the Moss Landing Marine Laboratory, are utilized by faculty and students in the meteorology and oceanography programs. Supplementing the school's extensive computer facilities, discussed in the General Information section of this catalog, the department also maintains its own Computer Facility to support faculty and staff research and student thesis/dissertation projects. Equipment includes a number of networked microcomputers, data and graphics terminals, plotters and printers.

COURSE OFFERINGS

MR0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

MR0999 SEMINAR IN METEOROLOGY (NO CREDIT). (2-0).
Students present results of thesis or other approved research investigation.
PREREQUISITE: Concurrent preparation of thesis or other acceptable research paper.

MR2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (1-2).
Introduction to FORTRAN and NPS mainframe computer as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

MR2200 INTRODUCTION TO METEOROLOGY (4-0).
An introductory course that treats the composition and structure of the atmosphere, thermodynamic processes, forces and related small- and large-scale motions, air masses, fronts, severe storms, solar and terrestrial radiation, general circulation and weather forecasting. PREREQUISITE: Department approval.

MR2210 INTRODUCTION TO METEOROLOGY/LABORATORY (4-2).
Same course as MR2200 plus laboratory periods illustrating lecture material, including Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis over oceanic areas, plus satellite imagery interpretation. PREREQUISITE: Department approval.

MR2262 ELEMENTS OF WEATHER FORECASTING (1-2).
Survey of subjective and objective methods of atmospheric prognosis. Weather briefings illustrate applications of forecasting principles and use of satellite imagery.
PREREQUISITES: MR3222, MR3230 or consent of instructor.

MR2413 METEOROLOGY OF ANTISUBMARINE WARFARE (3-1).
Atmospheric factors affecting the air-sea interface, and the marine atmospheric boundary layer; local and synoptic-scale atmospheric features relevant to electromagnetic and electro-optical wave propagation; hands-on experience with existing environmental effects assessment models. PREREQUISITES: Differential and integral calculus (may be taken concurrently).

MR2416 METEOROLOGY FOR ELECTRONIC WARFARE (2-0).
A survey of environmental factors affecting the propagation and attenuation of electromagnetic waves. Synoptic and climatological conditions associated with anomalous refraction are studied. Ionospheric phenomena associated with longer wavelength (Hf) propagation. Layers associated with high aerosol concentration and optical turbulence are identified. Hands-on experience with existing environmental effects assessment models. PREREQUISITES: Differential and integral calculus. (May be taken concurrently).

MR2419 ATMOSPHERIC FACTORS IN C3 (2-0).
A survey of atmospheric properties and processes affecting propagation of electromagnetic (EM) and electro-optical (EO) waves. Tropospheric phenomena associated with standard and anomalous EM wave propagation at wavelengths greater than 10 meters. Ionospheric

phenomena associated with larger wavelength (Hf) propagation. PREREQUISITE: Enrollment in C3 curriculum.

MR2520 SURVEY OF AIR-OCEAN REMOTE SENSING (3-0).
Overview of systems for remote sensing of the atmosphere and oceans from space, and operational applications. PREREQUISITES: Undergraduate physics and calculus, or consent of instructor.

MR3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3-2).
Basic probability and statistics, in the air-ocean science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation and variance. Binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one-and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

MR3150 ANALYSIS OF AIR/OCEAN TIME SERIES (3-2). Analysis methods for atmospheric and oceanic time series. Fourier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data networks. Laboratory work involves analysis of actual atmospheric and oceanic time series using principles developed in class. PREREQUISITES: MA3132 and a probability and statistics course.

MR3212 POLAR METEOROLOGY/OCEANOGRAPHY (4-0).
Operational aspects of arctic and antarctic meteorology. Polar oceanography. Sea-ice; amount, its seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. PREREQUISITES: OC3240, MR3222 or consent of instructor.

MR3220 METEOROLOGICAL ANALYSIS (4-0).
Techniques of evaluation, interpretation and analysis of pressure, wind, temperature and moisture data, including weather satellite observations, with emphasis on the low and middle troposphere. Synoptic models of extratropical vortices, waves and frontal systems, with emphasis on three dimensional space structure and time continuity, including isentropic surfaces and vertical cross-section analysis. Introduction to analysis in the high troposphere and low stratosphere, including daily exposure to Navy Operational Global Atmospheric Prediction System (NOGAPS) analysis. PREREQUISITES: MR3420, MR/OC3321.

MR3222 METEOROLOGICAL ANALYSIS/LABORATORY (4-3).
Same as MR3220 plus laboratory sessions on the concepts considered in the lectures, with emphasis on the analysis of the low and middle troposphere, streamline and isotach analysis techniques, satellite interpretation, and vertical cross-section analysis. PREREQUISITES: MR3420, MR/OC3321.

MR3230 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY (4-0).
Development and application of conceptual models of the evolution of various tropospheric and stratospheric circulation systems. Extratropical cyclones, jet streams and fronts are examined through application of dynamical concepts with particular emphasis on aspects associated with the marine environment. PREREQUISITES: MR3222; MR43222 (may be concurrent).

MR3234 TROPOSPHERIC AND STRATOSPHERIC METEOROLOGY/ LABORATORY (4-4).
Same as MR3230 plus laboratory sessions utilizing the IDEA Lab to facilitate the physical understanding of dynamic relationships inherent to the conceptual models of the various weather systems. Exercises utilize various case studies including material from recent marine cyclogenesis field experiments. PREREQUISITES: MR3222; MR4322 (may be concurrent).

MR3240 RADAR METEOROLOGY (3-0).
Principles of radar meteorology. Topics covered include radar systems, meteorological radar equation, doppler radar basics, propagation, attenuation, precipitation and velocity estimation, and characteristic echoes. PREREQUISITES: MR3222 and MR3522.

MR3250 TROPICAL METEOROLOGY (3-0).
Structure and mechanisms of synoptic-scale wave disturbances, cloud clusters, upper-tropospheric systems, the intertropical convergence zone; structure, development and motion of tropical cyclones; monsoon circulations. Emphasis on analysis and energetics. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be concurrent).

MR3252 TROPICAL METEOROLOGY/LABORATORY (3-4).
Same as MR3250 plus laboratory sessions on analysis of tropical systems emphasizing streamline and isotach analysis and incorporating aircraft and satellite observations. Exercises stress tropical cyclone regimes. Satellite imagery is used as an analysis tool and also in forecasting tropical cyclone intensity. A track forecasting exercise provides an exposure to the use of various dynamic, climatological and statistical forecast models. PREREQUISITES: MR4322 and MR3230 or MR3234 (may be concurrent).

MR3260 OPERATIONAL ATMOSPHERIC PREDICTION (3-0).
Subjective and objective methods of atmospheric prognosis and techniques for forecasting operationally-important weather elements from surface to 100 mb. Interpretation, use and systematic errors of computer-generated products. Weather satellite briefs and applications of forecasting principles to current situations. PREREQUISITES: MR3230, or MR3234; MR/OC4323 (may be concurrent).

MR3262 OPERATIONAL ATMOSPHERIC PREDICTION/LABORATORY (3-5).
Same as MR3260 plus laboratory sessions on the application of lecture material. Also, practice in weather briefing, including diagnosis and forecasting of current weather situations using weather satellite observations, and Fleet Numerical Oceanography Center and National Meteorological Center products. PREREQUISITES: MR3230 or MR3234; MR/OC4323 (may be concurrent).

MR3321 AIR-OCEAN FLUID DYNAMICS (4-0).
A foundation course for studies of atmospheric and oceanographic motions. The governing dynamical equations for rotating stratified fluids are derived from fundamental physical laws. Topics include: the continuum hypothesis, real and apparent forces, derivations and applications of the governing equations, coordinate systems, scale analysis, simple balanced flows, boundary conditions, thermal wind, barotropic and baroclinic conditions, circulation, vorticity, and divergence. PREREQUISITE: MA2047.

MR3420 ATMOSPHERIC THERMODYNAMICS (3-0).
Topics to be covered include: the physical variables, the equation of state, the first law of thermodynamics and its application to the atmosphere, meteorological thermodynamic diagrams, adiabatic processes and potential temperatures, moist air processes, hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. PREREQUISITE: MA1116 or equivalent.

MR3421 CLOUD PHYSICS (3-0).
Basic principles of cloud and precipitation physics and application to weather modification. Selected topics in atmospheric pollution. PREREQUISITE: MR3420.

MR3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2-2).
Principles of measurement: sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC3230 and MR3420, MR/OC3150 or consent of instructor.

MR3455 MEASUREMENT SYSTEMS FOR THE MARINE AND COASTAL ATMOSPHERIC BOUNDARY LAYER (2-2).
The course treats a broad spectrum of measurement techniques for atmospheric dynamic

and thermodynamic variables. Laboratory sessions provide hands-on experience with various state-of-the-art sensing systems, including NPS's new Doppler Radar Wind Profiler. Topics include sensor static and dynamic characteristics; calibration; in situ measurements of wind, pressure, temperature, humidity and radiation on the surface, on balloon-borne sounding systems and on aircraft; and surface-based remote sensing systems, including wind profilers, SODAR and LIDAR. PREREQUISITES: MR3222 and MR3150 or consent of the instructor.

MR3480 ATMOSPHERIC THERMODYNAMICS AND RADIATIVE PROCESSES (4-1).
Topics to be covered include: the physical variables, the equation of state, the first law of thermodynamics and its application to the atmosphere, meteorological thermodynamic diagrams, adiabatic processes and potential temperatures, moist air processes, hydrostatic equilibrium, vertical motion in the atmosphere, stability methods and criteria. Basic solar and terrestrial radiation theory; atmospheric energy budgets; climate change; radiative effects of clouds and aerosols. PREREQUISITE: MA1117 or equivalent.

MR3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4-0).
Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry and radar systems; application of satellite remotely sensed data in the measurement of atmospheric and oceanic variability. PREREQUISITES: Undergraduate physics and differential/integral calculus, ordinary differential equations and MR3480, or consent of instructor.

MR3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/ LABORATORY (4-2).
Same as MR3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as MR3520.

MR3540 RADIATIVE PROCESSES IN THE ATMOSPHERE (3-0).
Applications of radiation theory to atmospheric energy budgets, general circulation and anthropogenic climate changes. Radiational imbalance at the surface leading to heat fluxes and temperature changes in atmosphere and earth. Upper atmosphere phenomena (ozonosphere and ionosphere). Radiative effects of clouds and aerosols, and optical phenomena. PREREQUISITES: MR3420, MR3520 or MR3522.

MR3570 OPERATIONAL OCEANOGRAPHY AND METEOROLOGY (2-4).
Experience at sea acquiring and analyzing oceanographic and atmospheric data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea and post-cruise analysis. PREREQUISITES: OC3240 and MR3220, or consent of instructor.

MR4241 MESOSCALE METEOROLOGY (3-0).
Descriptive and physical understanding of subsynoptic-scale weather systems including fronts, squall lines, mesoscale convective systems, tornadoes, etc. and their relation to the synoptic-scale environment. Applications to short-range and local-area forecasting utilizing satellite and numerical-model products relevant to mesoscale weather phenomena. PREREQUISITES: MR3230, MR/OC4323, or MR4322 with consent of instructor.

MR4242 ADVANCED TROPICAL METEOROLOGY (3-0).
Theories and observations of equatorial waves and low-frequency oscillations; energy sources and instabilities; monsoon circulations. Tropical cyclone models and forecasting; selected topics in diagnostic and theoretical studies of tropical flows. PREREQUISITES: MR3250 and consent of instructor.

MR4250 ATMOSPHERIC GENERAL CIRCULATION (3-0).
The observed circulation. Zonal mean and eddy motions. Balances of momentum, heat and moisture. Energetics. Maintenance of circulation. Zonally asymmetric circulations. Other

selected topics of the general circulation of the atmosphere. PREREQUISITES: MR4322 and consent of instructor.

MR4322 DYNAMIC METEOROLOGY (4-0).
Pressure coordinates, quasi-geotrophic scale analysis, perturbation method; solutions of equations of motion for sound, gravity and synoptic waves; baroclinic and barotropic instability; energetics; geostrophic adjustment. PREREQUISITES: MR3420, MR/OC3321, MA2047, MA2121 or equivalent.

MR4323 NUMERICAL AIR AND OCEAN MODELING (4-2).
Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving hyperbolic, parabolic and elliptic equations, linear and nonlinear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. PREREQUISITES: MR4322, OC4211, MA3132; MA3232 desirable.

MR4324 ADVANCED NUMERICAL WEATHER PREDICTION (3-0).
Initialization, boundary conditions; sensible, latent and radiative heat transfer; simulation of sub-grid scale processes such as convection and friction; spectral methods and finite element models; general circulation models. PREREQUISITE: MR/OC4323 or consent of instructor.

MR4331 ADVANCED GEOPHYSICAL FLUID DYNAMICS I (3-0).
Advanced topics in the dynamics of the atmosphere and the oceans including scale analysis; geostrophic adjustment; dispersion, and barotropic and baroclinic instabilities. PREREQUISITE: Consent of instructor.

MR4332 ADVANCED GEOPHYSICAL FLUID DYNAMICS II (3-0).
Normal mode and absolute baroclinic instability; frontogenesis; boundary layer analysis with application; finite amplitude baroclinic waves. PREREQUISITE: Consent of instructor.

MR4413 AIR-SEA INTERACTION (4-1).
Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. PREREQUISITES: MR/OC3150 and OC3240 or MR4322, or consent of instructor.

MR4414 ADVANCED AIR/SEA INTERACTION (3-0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

MR4415 ATMOSPHERIC TURBULENCE (3-0).
Approaches for defining the structure of the turbulent atmospheric boundary layer. Review of statistical descriptions of atmospheric turbulence; averaging, moments, joint moments, spectral representation. Equations for turbulent regime in a stratified, shear flow. Scaling parameters and similarity theories for surface layer profiles, spectra; Kolmogorov hypotheses, Monin-Obukhov similarity theory. Measurement of atmospheric turbulence. Examination of observed spectra and scales of atmospheric turbulence. PREREQUISITE: MR/OC3150 or consent of instructor.

MR4416 ATMOSPHERIC FACTORS IN ELECTROMAGNETIC AND OPTICAL PROPAGATION (4-0).
Principles of microwave and optical wave propagation in the atmosphere. Effects of surface and boundary layers on propagation: refraction, scattering, attenuation, ducting, etc. Hands-on experience with existing environmental effects assessment models. PREREQUISITE: MR/OC4413 or MR4415 (may be concurrent).

MR4520 TOPICS IN SATELLITE REMOTE SENSING (3-0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

MR4800 ADVANCED TOPICS IN METEOROLOGY (Variable credit) (V-0).
Advanced topics in various aspects of meteorology. Topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITE: Consent of Department Chairman and instructor.

MR4900 DIRECTED STUDY IN METEOROLOGY (Variable credit) (V-0).
Directed study of selected areas of meteorology to meet the needs of the individual student. PREREQUISITE: Consent of Department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF NATIONAL SECURITY AFFAIRS

Chairman:
Thomas C. Bruneau
Professor
Code NS/Bn, Root Hall
Room 100
(408) 656-2521
DSN 878-2521

Associate Chairmen:

Administration
Ralph H. Magnus
Associate Professor
Code NS/Mk, Root Hall
Room 201C
(408) 656-2294
DSN 878-2294

Instruction
Scott D. Tollefson
Assistant Professor
CodeNS/To, Root Hall
Room 200
(408) 656-2863
DSN 878-2863

Research
Jan S. Breemer
Assistant Professor
Code NS/Be, Root Hall
Room 103E
(408) 656-3486
DSN 878-3486

Donald Abenheim, Associate Professor (1985)*; PhD, Stanford University, 1985.

Enrique Alvarez, Adjunct Research Instructor (1984); BA, Stanford University, 1988.

Sherman Wesley Blandin, Jr., Professor Emeritus (1968); PhD, University of Santa Clara, 1977.

Jan S. Breemer, Associate Chairman for Research and Assistant Professor (1988); PhD, University of Southern California, 1987.

R. Mitchell Brown, III, Commander, U.S. Navy (1989); OP 06 Chair of Strategic Planning; MA, Naval Postgraduate School, 1980; MBA, Wharton, 1976.

Thomas C. Bruneau, Chairman and Professor (1987); PhD, University of California at Berkeley, 1970.

Claude A. Buss, Adjunct Professor (1976); PhD, University of Pennsylvania, 1927.

Ralph Norman Channell, Adjunct Professor (1987); MA, Boston University, 1964.

Dana P. Eyre, Adjunct Professor (1991); PhD, Stanford University, 1992.

Thomas B. Grassey, Associate Professor (1987); PhD, University of Chicago, 1983.

Boyd Francis Huff, Professor Emeritus (1958); PhD, University of California, Berkeley, 1955.

Roman A. Laba, Assistant Professor (1990); PhD, University of Wisconsin, 1989.

Robert Edward Looney, Professor (1979); PhD, University of California at Davis, 1969.

Ralph Harry Magnus, Associate Chairman for Administration and Associate Professor (1976); PhD, University of California at Berkeley, 1971.

Gordon McCormick, Associate Professor (1992); PhD, Johns Hopkins SAIS, 1985.

Rodney Minott, Adjunct Professor (1990); PhD, Stanford University, 1960.

Edward Allan Olsen, Professor (1980); PhD, The American University, 1974.

Patrick Johnston Parker, Professor (1974); MBA, University of Chicago, 1955.

Glenn Edward Robinson, Assistant Professor (1991); PhD, University of California at Berkeley, 1992.

Kamil T. Said, Adjunct Professor (1975); MA, San Jose State College, 1967.

Paul N. Stockton, Assistant Professor (1990); PhD, Harvard University, 1986.

Russel Henry Stolfi, Professor (1966); PhD, Stanford University, 1966.

Frank Michael Teti, Associate Professor (1966); PhD, Syracuse University, 1966.

Scott D. Tollefson, Assistant Professor (1988); PhD, Johns Hopkins University, 1991.

James John Tritten, Associate Professor (1986); PhD, University of Southern California, 1984.

Mikhail Tsypkin, Associate Professor (1987); PhD, Harvard University, 1985.

David B. Winterford, Adjunct Professor (1984); PhD, Univeristy of British Col.

James J. Wirtz, Assistant Professor (1990); PhD, Columbia University, 1989.

David Scott Yost, Professor (1979); PhD, University of Southern California, 1976.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Department of National Security Affairs offers programs of study in four major fields, supporting seven different curricula. The four major fields encompass Strategic Planning and International Organizations and Negotiations, Intelligence, Geographic area studies and Special Operations/Low Intensity Conflict. The area studies are subdivided into five groups as follows:

- Middle East, Africa and South Asia
- Far East, Southeast Asia and the Pacific
- Western Hemisphere
- Western Europe
- Russia/Europe/Central Asia

Individual programs in the area studies focus on one of the subregions listed or contain a blend of all subregions in the area. The area studies program may include a program of study in a language of the area at the Defense Language Institute, located in Monterey.

The field of strategic planning includes both general and nuclear strategic planning. Individual programs focus on the evolutionary history of the planning process, strategies for national security, maritime strategy and management and planning systems.

The intelligence curriculum is an interdisciplinary program which integrates political science, mathematics, operations analysis, oceanography, aeronautical engineering, electrical engineering, physics, information systems and managerial economics into an understanding of intelligence.

The Special Operations/Low Intensity Conflict curriculum provides a focused scope of study of the conflict spectrum below general conventional war. Courses deal with the following topics: international terrorism, theory and practice of guerrilla warfare, role of contingency operations in U.S. security planning, comparative approaches to the problem of low intensity conflict, and the military and politics in the developing world.

Coursework addresses four broad fields: defense technology, analysis, management and national security affairs. The defense technology courses are designed to address the

special problems of technical intelligence, emphasizing technical literacy and the ability to communicate concerning technological and environmental problems. This sequence seeks to provide the perspective that will assist assessment of the reality and significance of technical and environmental data, as well as ensure familiarity with the resources in these fields that may be applied to intelligence problems.

The analysis and management coursework provides the student with a grounding in quantitative techniques, substantive research methods and the concepts of resource management. Students are introduced by various means to structure given problems, formulate possible solutions, organize and compile supporting data, assess the reliability and communicate the significance of the results obtained.

Graduate courses in National Security Affairs outline the interface between international politics, national security objectives, resource management and weapons technology. The sequence synthesizes the political, technological, economic, cultural, social and ideological forces that influence the actors in the international system and models varying scenarios of interaction between them.

The newest of the NSA programs is the Special Operations/Low Intensity Conflict (SOLIC) curriculum which was created to provide graduate level education to respond to present and most likely forms of conflict or "peacetime engagement." The courses pay particular attention to regional contingency missions, including counterinsurgency, counternarcotics, counterterrorism, and crisis response operations.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF ARTS IN NATIONAL SECURITY AFFAIRS

1) At least 44 units of approved graduate study pertinent to the field of National Security Affairs, of which at least 16 units must be at the 4000 level.

2) The completion of an approved sequence of courses in one of the areas of concentration:

   a. Area Specialization: Completion of graduate courses in the geographic area of specialization, including a 4000 level course.

   b. Functional Specialization: Completion of graduate courses in either Strategic Planning and International Organizations and Negotiations or Special Operations Low Intensity Conflict including a 4000 level course.

3) Successful completion of departmental comprehensive examination or completion of an acceptable thesis.

4) Language proficiency, when applicable, for geographic area specialization.

DEPARTMENTAL REQUIREMENTS FOR THE DEGREE MASTER OF SCIENCE IN NATIONAL SECURITY AFFAIRS

The degree Master of Science in National Security Affairs will be awarded upon the completion of an interdisciplinary program carried out in accordance with the following degree requirements:

1) A minimum of 45 quarter hours of graduate level work of which at least 12 hours must represent courses at the 4000 level. Graduate courses in at least three different academic disciplines must be included and in two disciplines a course at the 4000 level must be included.

2) An approved sequence of at least three courses constituting advanced study in an area of specialization must be included.

3) In addition to the 45 hours of course credit, an acceptable thesis must be completed.

4) The program must be approved by the Chairman of the Department of National Security Affairs.

COURSE OFFERINGS

NS0810 THESIS RESEARCH (0-0).
Students conducting thesis research will enroll in this course.

NS0811 PREPARATION FOR COMPREHENSIVE EXAMINATION
Students preparing for comprehensive examinations will enroll in this course.

NS0855 EXPERIENCE TOUR (0-0).
Thesis research assignment to the Naval Maritime Intelligence Center (NAVMIC) and other Washington area intelligence organizations, for selected students in Track 1 and Track 3A of the Intelligence curriculum. PREREQUISITES: Approval of Academic Associate for Intelligence, TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS3000 WAR IN THE MODERN WORLD (4-0).
An introduction to the phenomenon of war as a feature of politics and society as well as a force in the international system of states. Chief emphasis is upon the development of leading ideas about war; the evolution of strategic thought and practice; the interconnections of politics and society in war; an analysis of the levels of war; an examination of national styles in war and their implications for contemporary strategic practice.

NS3011 POLICY ANALYSIS AND RESEARCH METHODS (4-2).
Survey of the methods and techniques used in social scientific inquiry. Topics include policy research design, measurement, sampling, and generation of data using survey research, scaling techniques, interviewing, content analysis, analysis of elites, event data analysis, and archival and bibliographic research techniques. The course emphasizes hypothesis testing, using both statistical methods and the method of structured, focused comparison of case studies. Special focus is placed on applying the principles and methods of social science to the general problem of indications and warning. Laboratory experience includes extensive use of the equipment and software in the NSA computer lab.

NS3012 FORECASTING AND GAMING METHODS FOR STRATEGIC PLANNERS (4-2). (Note: new course, combines NS2060 and NS3013).
Survey of concepts and methods employed in forecasting, wargaming, and simulation that are available for use by military planners and strategists. Includes historical development and recent forecasting, analytical gaming, and simulation techniques applicable to national security planning. Examines a variety of forecasting and gaming methodologies, including the RAND Strategy Assessment System (RSAS). Emphasis is on current and potential uses in the development of strategy, plans and policy. PREREQUISITES: NS301 and SECRET NOFORN.

NS3023 INTRODUCTION TO COMPARATIVE POLITICS (4-0). (Note: revised course, International Relations now taught as NS3024).
This course is designed to introduce students to the major intellectural approaches to the study of comparative politics. Readings will be drawn from major theorists and leading schools of thought. Students will confront the central questions on the nature of economic, political, and cultural development.

NS3024 INTRODUCTION TO INTERNATIONAL RELATIONS (4-0). (Note: new course, separate from NS3023)
This course provides an overview of the prominent theories of international relations. It surveys explanations based on decision-making, organizational behavior, domestic politics, international regimes and international systems, especially in terms of the insights they offer into the conduct of international relations in the post-Cold War world.

NS3030 AMERICAN NATIONAL SECURITY POLICY (4-0).
An institutional and functional analysis of the national and international factors that

shape U.S. defense policy. Attention is focused on two major areas: (1) the decision-making process, including the legislative-executive budgetary process, as well as the influence of bureaucratic politics and interest group participation upon defense decisions; and (2) the problems of strategic choice, including security assistance, threat analysis, net assessment, deterrence theory, and limited war.

NS3036 THE MILITARY AND POLITICS IN THE DEVELOPING WORLD (4-0).
This course examines the diverse political roles played by the military and paramilitary establishments of the Third World. Particular attention is given to the character of Third World civil-military relations and the pressures, motivations, and consequences of military coups against the established political order. The course examines the different classes of military coups, the relationship between national political culture and military intervention, and the varying methods of intervention open to the armed forces. The course will conclude with an examination of different types of military governments, the consequences of military rule for national stability, and problems inherent in the transition to civilian rule, and the consolidation of democratic regimes. Case studies are drawn from Africa, Latin America, the Middle East, and the Far East with the intention of identifying common and regional patterns in the character and disintegration of Third World civil-military relations. PREREQUISITE: NS3023 or permission of the instructor.

NS3037 THE ROLE OF CONGRESS IN U.S. NATIONAL SECURITY POLICY (4-0)
Survey of the roles, processes and orientations of the U.S. Congress in making national security policy. The course examines the powers and responsibilities granted to Congress by the Constitution, how the role of Congress has changed over time, and the way the role may evolve in the future. Specific topics include the budget process, War Powers, security assistance, and the problems of executive-legislative coordination in foreign and military policy-making.

NS3038 INTERNATIONAL NAVAL POWER AND POLICY (4-0).
This course examines the role of international maritime power in peace, crisis and war. It reviews the evolution of the post-World War II global balance of naval power, the roles, missions and capabilities of the principal regional navies (e.g., Japan, India, China, Western Europe, Brazil, and Argentina), and the impact of technological innovation on regional maritime strategies, threats and risks. Specific threat capabilities covered include the proliferation of underwater threat systems (e.g., submarines, mines) and precision-guided weapons. The course focuses on regional, non-superpower naval developments, and their implications for U.S. maritime policy and strategy. PREREQUISITE: NS3252 or permission of the instructor.

NS3040 THE POLITICS OF GLOBAL ECONOMIC RELATIONS (4-0).
Examination of the world economy. Focuses on implications for the United States of changes in the world trading and financial systems. Topics covered include trade patterns economic integration, trade blocs, new international economic order, and international economic organizations.

NS3041 COMPARATIVE ECONOMIC SYSTEMS (4-0).
An examination of the economic systems and development problems in developing countries, including post-communist states. The course focuses on the political and ideological bases of economic organizations, and the nature of basic economic problems in these regions. Special attention is given to the socio-economic strategies and tactics used in the management of the economy, and institutions and techniques of decision making. Attention is also given to problems of economic stabilization in the developing world. PREREQUISITE: NS3040.

NS3079 DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit; 1-0 to 4-0). (Note: new course, previously NS3279).
Format and content vary. Normally involves extensive assigned readings, individual discussions with the instructor, papers and /or examinations.

NS3150 SCIENCE AND TECHNOLOGY OF INTELLIGENCE (4-0). (Note: new course number and description - previously NS2150).

This course introduces the terminology, concepts, and scientific principles of the technology of modern weapons and sensors, particularly those of importance to technical intelligence collection. Topics include energy propagation; computer, communication, and radar system fundamentals; basic aerodynamics and orbital mechanics; weapons design and effects; and concepts of remote sensing.

NS3151 INTELLIGENCE SYSTEMS AND PRODUCTS (4-0). (Note: new course, replaces NS2154)
All-source overview of U.S. and foreign intelligence collection, analysis, and dissemination capabilities for IMINT, SIGINT, MASINT and HUMINT, from national to tactical levels. The course aims to be comprehensive at an introductory level but intensive on selected key systems. It is required for students in the Intelligence curriculum, and also intended for students in the Strategic Planning, SOLIC, and Academic Groups curricula (Joint C3, Space Systems, EW, and ASW). PREREQUISITES: TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS3152 NAVAL WARFARE AND THE THREAT ENVIRONMENT (4-0).
This course concentrates on identifying the key warfare issues for successful accomplishment of the U.S. Navy's missions. The evolution of threats is examined in the context of present and future U.S. strategy. PREREQUISITE: SECRET clearance is required.

NS3154 INTELLIGENCE AND THE MILITARY (4-0).
Overview of the intelligence structure and survey of the intelligence processes focusing on the application of intelligence to military missions, including lessons from Operation Desert Storm. The organization and functions of the various elements of the intelligence community are considered. Primary emphasis is placed on the use of intelligence by military decision makers. The course includes an introduction to systems and organizations supporting the collection, production and dissemination of intelligence. The course is intended for the non-intelligence specialist and military planners who are primary users of intelligence. PREREQUISITE: SECRET NOFORN.

NS3159 PRINCIPLES OF OPERATIONAL INTELLIGENCE (4-0).
A survey of the concepts, principles, and methods of all-source, time-urgent support to meet operational commanders' intelligence requirements across the entire spectrum of conflict. Indications and warning, EEIs and collection plans, intelligence watch and battle staff functioning, crisis management, mission planning, tasking of non-organic intelligence assets, operational security, and deception. Emphasis is placed on case studies. PREREQUISITE: TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS3230 STRATEGIC PLANNING AND THE MILITARY (4-0).
Introduction to strategic planning approaches and methods inherent to national security policy formulation and specifically, military defense planning. Includes long range strategic planning, scenario building and forecasting of macro-trends affecting defense policies and capabilities, and the military dimensions of those factors. Theory and process meet through case study/analysis of U.S. defense planning practices and the evolution of the Joint Strategic Planning System (JSPS), including the changing roles of the Joint Staff, Unified CINC and Component, Joint Task Force, and Service staffs following passage of the Goldwater-Nichols Act and post-Cold War international security developments. PREREQUISITES: NS3030, NS3252 (may be taken concurrently) and SECRET NOFORN.

NS3250 THE ECONOMICS OF U.S. DEFENSE POLICY (4-0).
An examination of the manner in which economic constraints affect the defense allocation process in the United States. Emphasis is placed on the macroeconomic environment in which the budget process in undertaken. Topics include: factors affecting defense expenditures; budgeting for defense; the impact of defense spending on the economy; manpower' and the structure, conduct and performance of defense industries. PREREQUISITE: NS3040 or permission of the instructor.

NS3252 JOINT & MARITIME STRATEGIC PLANNING (4-0).
The student will have a graduate level understanding of strategy, especially maritime strategy, naval doctrine, and the effect of technical developments on warfare. The student will become familiar with the following subjects for the United States, its allies, and opponents: the roles and missions of military services, policy-making processes regarding the armed forces, history of joint and general staffs, joint planning for acquisition and operations, and current issues in defense reform and reorganization. Required for all U.S. officer students. PREREQUISITES: U.S. Citizenship and SECRET clearance.

NS3280 NUCLEAR STRATEGY AND NATIONAL SECURITY (4-0).
This course surveys the history of U.S. nuclear weapons policies and explores deterrence and arms control theories. The course also evaluates the challenges posed by the proliferation of weapons of mass destruction and advanced delivery sytems. PREREQUISITE: NS3252 or permission of the instructor.

NS3300 HISTORY AND CULTURES OF THE MIDDLE EAST (4-0).
Introduction to the basic geography, culture, society, economy, and religions of the major ethnic and linquistic groups in the Middle East. The course will introduce students to important events and developments, such as the changing conceptions of politics in Islam; the evolving sociological bases of states and societies in the Middle East; and the early impact of Europe on the Middle East, first through trade and then through colonialism.

NS3310 GOVERNMENT AND POLITICS IN THE MIDDLE EAST (4-0).
This introductory course is designed to familiarize students with the politics of contemporary Middle East. The course will cover such topics as the various types of political systems found in the Middle East, the political economy of development, and ethno-nationalist and Islamicist political movements.

NS3320 UNITED STATES INTERESTS AND POLICIES IN THE MIDDLE EAST (4-0).
This course reviews the historical background and current status of American interests and policies in the Middle East. The course focuses on a variety of issues that have occupied American interests, such as: the Arab-Israeli conflict, the security of oil resources revolutionary change, regional conflicts, and international rivalry of external powers.

NS3360 TOPICS IN MIDDLE EASTERN POLITICS (4-0).
This course will examine various topics of central importance in contemporary Middle Eastern politics. These include, for example, nationalism and the state in the Middle East the politics of Islamicist movements, and the politics of oil.

NS3361 TOPICS IN MIDDLE EASTERN SECURITY (4-0).
This course will examine topics of central importance to contemporary Middle Eastern security. It will focus on security issues in at least one of the following: the Maghreb, Israel, the Northern Tier, and the Arabian Peninsula and the adjacent areas.

NS3400 GOVERNMENT AND POLITICS IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4-0).
An examination of the role of domestic politics in Russia, Eastern Europe, and Central Asian nations. The emphasis is on historical influences, political institutions, ethnic and social problems, and the economy.

NS3401 ETHNO-NATIONALISM IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4-0).
This course introduces students to the states and societies of Russia, Ukraine, Belarus, Latvia, Estonia, Lithuania, Moldova, Georgia, Azerbaijan, Armenia, Kazakhstan, Uzbekistan, Turkmenistan, and Kirgiztan. It also serves as a basic introduction to the broader study of ethnicity and nationalism.

NS3410 RUSSIA, EASTERN EUROPE AND CENTRAL ASIA IN WORLD AFFAIRS (4-0).
This course is concerned with the international conduct and security policies of Russia, the

other countries of Eastern Europe, and Central Asia. It examines their major geopolitical, historical, demographic, and economic influences.

NS3450 MILITARY STRATEGY IN RUSSIA, EASTERN EUROPE, AND CENTRAL ASIA (4-0).
The course examines the international factors that condition military strategy and doctrine in Russia, Eastern Europe, and Central Asia. It focuses on contemporary strategic concepts and strategy: conventional war-fighting capabilities, strategy for nuclear war, roles played by the fleets in military strategy, threat and net assessment, and arms control. Emphasis is on the strategic and operational levels of warfare.
PREREQUISITES: NS3252 and SECRET clearance.

NS3460 GOVERNMENT AND SECURITY IN EASTERN EUROPE (4-0).
This course examines the countries of east central Europe that fell in the Soviet sphere of influence after World War II. It is concerned in particular with the complex relationship of Marxism and nationalism, the nature of communist revolution from abroad, revolutions against communist states including Hungary in 1956 and Poland in 1980, and the present situation of the Central European states in the transition from communism to democracy.

NS3501 HISTORY AND CULTURES OF LATIN AMERICA (4-0).
This introductory course examines the heritage of Latin America, from pre-Columbian Indian traditions and Iberian colonial patterns, through the independence movements of the early 19th century, and the global economic relationships that re-oriented the region toward Northwestern Europe and the United States.

NS3510 GOVERNMENT AND POLITICS IN LATIN AMERICA (4-0).
This introductory course is designed to familiarize students with the politics of contemporary Latin America. The course will cover such topics as the various types of political systems found in Latin America, the political economy of development, and the issue of regime transition.

NS3520 LATIN AMERICAN INTERNATIONAL RELATIONS (4-0).
This course surveys the international relations of Latin American nations. It analyzes the relations of Latin America with the United States and other nations, both within and outside of the region. Attention is given to political, security, economic and cultural issues.

NS3600 HISTORY AND CULTURES OF EAST ASIA (4-0).
Addresses the historical development of the peoples of East, South, and Southeast Asia. It emphasizes their economic, political, and military development through the late 19th century.

NS3601 VALUES AND BELIEF SYSTEMS OF ASIA (4-0).
An introduction to the values and belief systems that have shaped the civilizations of East, South, and Southeast Asia. This course addresses the development and practices of Hinduism, Buddhism, Confucianism, Islam, Taoism, Shintoism, and other belief systems, and the ways they influenced traditional and modern Asia.

NS3620 ASIA AND THE MODERN WORLD (4-0).
An analysis of major national and international developments within Asia, and between Asia and the non-Asian world from the mid-19th century to the late-20th century. Includes an examination of U.S. relations with Asia.

NS3661 GOVERNMENT AND SECURITY IN CHINA (4-0).
An examination of the rise of the Chinese Communist party and establishment of the Communist state; its domestic achievements and problems; the special problem of Taiwan; changing foreign policies and the current role of the People's Republic of China in world affairs. Includes an examination of U.S. relations with China.

NS3662 GOVERNMENT AND SECURITY IN JAPAN (4-0).
An examination of Japan in the contemporary world, focusing on Japan's political

dynamics, economic evolution, social transformation, the National Self Defense Forces, and alternatives for ensuring national security. Includes an examination of U.S. relations with Japan.

NS3663 GOVERNMENT AND SECURITY IN KOREA (4-0).
An examination of the division of the Korean nation into two states; the aftermath of the Korean war; domestic political, economic and social problems, of North Korea and South Korea; the prospects for reunification; the military balance and the changing strategic environment; and the relations of Pyongyang and Seoul with their key allies. Includes an examination of U.S. relations with Korea.

NS3667 GOVERNMENT AND SECURITY IN SOUTH ASIA, SOUTHEAST ASIA, AND OCEANIC REGIONS (4-0).
Examines domestic issues and foreign relations among the states in the region of South Asia, Southeast Asia, Australia, New Zealand, and Melanesia. Analyzes the importance of the Indian Ocean and Southwestern Pacific Ocean area, and the strategic interests of the major powers, including the United States.

NS3700 HISTORY OF MODERN EUROPE (4-0).
Review and analysis of the political and military history of Europe, including Russia, from the Congress of Vienna to the present.

NS3710 GOVERNMENT AND SECURITY IN WESTERN EUROPE (4-0).
Survey and analysis of government and security issues in contemporary Western Europe. The course emphasizes the political systems and security policies of Britain, France, Italy, and Germany.

NS3720 EUROPEAN SECURITY INSTITUTIONS (4-0).
Survey and analysis of the main international institutions dealing with European security, including the North Atlantic Treaty Organization (NATO), the Conference on Security and Cooperaton in Europe (CSCE), the Western European Union (WEU), and the European Community (EC). The survey will include selected challenges facing each organization, particularly NATO, and their relation to specific European countries and to U.S. foreign and defense policy. PREREQUISITE: NS3252 or permission of the instructor.

NS3800 THEORY AND PRACTICE OF SOCIAL REVOLUTION (4-0).
This course provides an overview of insurgency and counterinsurgency. It reviews the theoretical literature and offers an operational focus, by examining the alternative models of insurgency provided by the doctrine of "people's war," "foco theory," and the urban guerrilla. It also examines the roots and development of U.S. counterinsurgency doctrine, the difference between the "hearts and minds" and systems prescriptions of counterinsurgency, and alternative British, French, and Soviet concepts of counterinsurgency. Four special topics are also analyzed: the role of terror in revolutionary warfare, the relationship between narcotics and insurgency, the questions of guerrillas in power, and a comparison of U.S. counterinsurgency strategy in Vietnam and El Salvador with that currently pursued elsewhere. The course concludes with an examination of the future of guerrilla warfare. PREREQUISITE: NS3023 or permission of the instructor.

NS3801 INTERNATIONAL TERRORISM (4-0).
This course provides an in-depth examination of the origins, nature, and political/military roles of contemporary international terrorism. It briefly examines the early history of terrorism, the contending theories that purport to explain the sources of terrorist behavior, the different types of terrorism and terrorist actions, and the challenge international terrorism poses for American interests and foreign policy. Functional topics, such as the special problems posed by state-sponsored terrorism, the relationship between terrorism and the media, and the range of possible military responses to terrorism are also examined. The course will conclude by comparing the contrasting different national responses to the problem of international terrorism, and examining the difficulties faced by the United States in its efforts to find an effective policy response. PREREQUISITE: NS3023 or permission of the instructor.

NS3880 THE HISTORY OF SPECIAL OPERATIONS (4-0).
Review and analysis of the history of Special Operations from World War II to the present. Case studies of the use of Special Operations Forces by the U.S. and other countries will be examined. PREREQUISITE: NS3023 or permission of the instructor.

NS3881 INTERVENTION AND MID-LEVEL CONFLICT (4-0).
This course provides an overview of the history and current role of (a) military force as a political instrument and (b) contingent intervention in U.S. foreign policy. It examines the nexus between unconventional and conventional warfare concepts and capability. The course is divided into two parts. Part one reviews the political or signalling role of miltary forces-notably naval forces-short of war. Part two examines the history of U.S. armed intervention and contingent operations in the Third World. The course examines the planning process underlying these and similar actions, and the special decision making problems posed by the need for unanticipated military action in the face of an unclear intelligence picture. PREREQUISITE: NS3800 or permission of the instructor.

NS3900 INTERNATIONAL LAW AND ORGANIZATIONS (4-0).
An introduction to the principles of international law including origins, sources, sovereignty, states, territory, jurisdiction, persons, treaties, settlement of disputes, and the Law of the Sea. The course also traces the evolution of international organizations from the Concert of Europe, through the League of Nations, United Nations, European Economic Community, NATO, and various forms of multi-national and trans-national organizations.

NS3902 MODERN REVOLUTION (4-0).
A study of a general framework and historical cases of modern revolution. Examines the most important revolutions of modern times, including the testing of the methods of systematic analysis.

NS4030 SPECIAL TOPICS IN NATIONAL SECURITY POLICY (4-0).
This course will focus on special topics in national security policy. The list of topics to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor.

NS4031 SPECIAL TOPICS IN INTERNATIONAL SECURITY AFFAIRS (4-0).
This course will focus on current issues in international security affairs. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor.

NS4032 SPECIAL TOPICS IN INTERNATIONAL RELATIONS (4-0).
This course will focus on current issues in the broader international system. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. A major, graded research paper is required. PREREQUISITE: Permission of the instructor.

NS4033 SPECIAL TOPICS IN U.S. FOREIGN POLICY (4-0). (Note: new course, offered in place of NS3035).
This seminar focuses on contemporary issues in U.S. foreign policy. The list of issues to be analyzed for the seminar is announced at least one quarter prior to the offering of the seminar. Advanced study and research is conducted on topics not covered in other seminars. PREREQUISITE: Permission of the instructor.

NS4079 ADVANCED DIRECTED STUDIES IN NATIONAL SECURITY AFFAIRS (Variable credit, from 1-0 to 4-0).
Format and content vary. Normally involves extensive individual research under direction

of the instructor and submission of a substantial paper of graduate seminar quality and scope. PREREQUISITE: Permission of the instructor.

NS4080 RESEARCH COLLOQUIUM (2-0). (Note: new course)
A researh colloquium in which NSA/Intelligence students present the main findings from their master's thesis research for critical analysis and discussion. GRADE: Pass/Fail.

NS4152 SEMINAR IN INTELLIGENCE AND THREAT ANALYSIS (4-0).
Advanced seminar on intelligence support to military commanders and national-level officials. Using case studies, the course examines concepts of individual and organizational decision-making, factors in threat analysis, and issues in intelligence activities. PREREQUISITES: NS3151 or permission of the instructor. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4159 SEMINAR IN ADVANCED TOPICS IN OPERATIONAL INTELLIGENCE (4-0).
Application of concepts, principles, and methods studied in previous Intelligence courses. Use of computer decision-support systems, operations analysis methods, intelligence products, threat assessment processes, and wargaming facilities in illustrative cases across the spectrum of warfare. PREREQUISITES: NS3159 or permission of the instructor. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4200 SEMINAR IN THE NATIONAL INTEREST (4-0). (Note: previously NS4500).
An advanced study of the underlying assumptions and objectives of American security and foreign policy. The core of the course is an in-depth analysis of approaches to understanding the American national interest in the international context. Students are required to write a major seminar paper on American national interests in a specific country or region. PREREQUISITES: NS3252 and NS3030.

NS4230 SEMINAR IN STRATEGIC PLANNING (4-0).
Advanced study in the concept and methods of strategic planning and analysis, particularly with respect to the Department of the Navy and other services, the Joint Chiefs of Staff, the Office of the Secretary of Defense, the Department of State, the National Security Council, White House, and the Congress. PREREQUISITES: NS3030 and NS3230 or permission of the instructor. SECRET clearance.

NS4250 SEMINAR IN SECURITY ASSISTANCE AND ARMS TRANSFERS (4-0).
An analysis of the patterns, purposes and effects of cross-national security assistance, including arms sales and the transfer of technology. Special topics include: factors dominating the arms transfer policies of the major powers; the design, execution and evaluation of security assistance programs. PREREQUISITE: NS3030.

NS4251 SEMINAR IN NET ASSESSMENT (4-0). (Note: new course).
The seminar examines the methodology of comparative threat analysis (net assessment), including: security policies, forces, and capabilities of the world's military superpowers. The course introduces the student to original source material. PREREQUISITES: NS3230 NS3252, NS3280, and NS3450. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4253 TECHNOLOGY AND STRATEGIC PLANNING (4-0).
This course is intended to develop an understanding of the interrrelationship of technology and strategic planning. Issues include technological risk, affordability, institutional impediments to innovation, and a strategy for long range technology investments. PREREQUISITE: NS3030, or NS3230, or NS3252, or permission of the instructor. SECRET clearance.

NS4261 SURVEY OF STRATEGIC STUDIES (4-0).
Survey of the classical and contemporary literature on strategic thinking: national objectives and strategic alternatives; deterrence, counterforce, arms control,

counterinsurgency; components and rules of the international strategic system; and arms competitions, nuclear proliferation, and terrorism. PREREQUISITE: NS3030 or permission of the instructor.

NS4280 SEMINAR IN NUCLEAR STRATEGY (4-0).
A follow-up course to NS3280 that examines selected issues in nuclear strategy, the proliferation of weapons of mass destruction, and deterrence. In addition to theoretical issues of deterrence, this course will specifically investigate the role and importance of nuclear force planning and strategy formulation in deterrence, stability, and foreign policy implementation. PREREQUISITES: NS3280. TOP SECRET clearance and, depending on the instructor's requirements, eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4300 SEMINAR IN MIDDLE EASTERN POLITICS (4-0).
A research seminar on politics in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern politics. PREREQUISITE: NS3300 or permission of the instructor.

NS4310 SEMINAR IN MIDDLE EASTERN SECURITY ISSUES (4-0).
A research seminar on security issues in contemporary Middle East. Students conduct and present original research on selected issues concerning Middle Eastern security. PREREQUISITE: NS3310 or permission of the instructor.

NS4410 SEMINAR IN SECURITY ISSUES IN RUSSIA, EASTERN EUROPE AND CENTRAL ASIA (4-0).
This advanced seminar addresses the security problems of the successor states to the former Soviet Union, focusing on the military, the security environment, political culture, Russian and non-Russian nationalisms, and the relationship between domestic and foreign policies. PREREQUISITE: NS3400, or NS4310, or NS3450, or permission of the instructor.

NS4451 SEMINAR IN RUSSIAN/CENTRAL EURASIAN NAVAL AFFAIRS (4-0).
Advanced study in emerging Russian/Central Eurasian naval and maritime affairs in the context of a changing international security environment. Topics include: politico-military decision-making processess, scenario building, military doctrines and strategies, strategic missions, naval operationl art, warfare capabilities and support systems, data bases and gaming, threat and net assessment, and arms control. PREREQUISITES: NS3252 and/or NS3450. TOP SECRET clearance with eligibility for SPECIAL COMPARTMENTED INTELLIGENCE information.

NS4510 SEMINAR IN LATIN AMERICAN GOVERNMENT AND POLITICS (4-0).
An advanced seminar on Latin American politics in government. The topics analyzed include those of most current relevance including political transitions, the changing role of difference political movements and institutions, and the prospects for economic growth and political stability. PREREQUISITE: NS3510 or NS3520, or permission of the instructor.

NS4560 SEMINAR IN LATIN AMERICAN SECURITY ISSUES (4-0).
A research seminar on security issues in contemporary Latin America. Students conduct and present original research on selected issues concerning Latin American security. PREREQUISITE: NS3510 or NS3520, or permission of the instructor.

NS4660 SEMINAR IN ASIA IN WORLD AFFAIRS (4-0).
Advanced study of Asia's contemporary economic, security, diplomatic, and cultural roles in world affairs, with special emphasis upon the policy interaction of China, Japan, India, and other key states with the United States, Russia, Europe, and the developing world. PREREQUISISTE: A NS3000-level course on Asia, or permission of the instructor.

NS4690 SEMINAR IN INTERNATIONAL SECURITY ISSUES OF ASIA (4-0).
Advanced study of Asian security issues with special emphasis on the balance of forces, regional and external alliances, prospects for conflict, and Asian concepts of security and strategy. PREREQUISITE: A NS3000-level course on Asia, or permission of the instructor.

NS4710 SEMINAR IN EUROPEAN POLITICS (4-0).
A research seminar on politics in contemporary Europe. Students conduct and present original research on selected issues concerning European politics, with an emphasis on defense and security problems. PREREQUISITE: NS3710 or permission of the instructor.

NS4720 SEMINAR IN EUROPEAN SECURITY ISSUES (4-0)
A research seminar on security issues in contemporary Europe. Students conduct and present original research on selected issues concerning European security. PREREQUISITE: NS3720 or permission of the instructor.

NS4850 REGIONAL SEMINAR IN LOW-INTENSITY CONFLICT (4-0)
There are three separate courses offered under the Regional Seminar Series. These will focus, respectively, on contemporary and historical low intensity conflict issues in Latin America, the Middle East, and Asia. The courses will examine the pertinent theoretical literature on political violence in the region in question, review the recent history of regionally-based terrorism and insurgency, offer a series of detailed case studies of local organizations and conflict, and focus on functional issues of particular interest or concern in the region under investigation. In each case, the seminar would be designed to provide the student with an advanced, regionally oriented grounding in contemporary LIC issues. PREREQUISITES: NS3036, NS3800 and NS3880.

NS4900 SEMINAR IN INTERNATIONAL NEGOTIATIONS (4-0).
Advanced study in the international negotiating process, designed to provide students with an opportunity to analyze specific topics related to negotiating national security. PREREQUISITE: NS3900 or permission of the instructor.

NS4902 SEMINAR IN MODERN REVOLUTION (4-0).
A research seminar on modern revolution. Students conduct and present original research on selected issues concerning modern revolution. PREREQUISITE: NS3902 or permission of the instructor.

DEPARTMENT OF OCEANOGRAPHY

Mary Louise Batteen, Associate Professor (1985)*; PhD, Oregon State University, 1984.

Robert Hathaway Bourke, Professor (1971); PhD, Oregon State University, 1972.

Everett Carter, Assistant Professor (1990); PhD, Harvard University, 1986.

Ching-Sang Chiu, Associate Professor (1988); ScD, Massachusetts Institute of Technology and Woods Hole Oceanographic Institution, 1985.

Peter C. Chu, Associate Professor (1986); PhD, University of Chicago, 1985.

James R. Clynch, Adjunct Research Professor (1990); PhD, Brown University, 1974.

Curtis Allan Collins, Chairman and Professor (1987); PhD, Oregon State University, 1967.

Newell Garfield, III, Adjunct Research Professor (1989); PhD, University of Rhode Island, 1989.

Roland William Garwood, Professor and Associate Chairman for Academics, (1976); PhD, University of Washington, 1976.

Eugene Clinton Haderlie, Adjunct Distinguished Professor Emeritus (1965); PhD, University of California at Berkeley, 1950.

Glenn Harold Jung, Professor Emeritus (1958); Texas A & M University, 1955.

Dale Fredrick Leipper, Professor Emeritus (1968); PhD, Scripps Institution of Oceanography, 1950.

John L. Newton, Adjunct Research Professor (1990); PhD, University of Washington, 1973.

Jeffrey Aaron Nystuen, Assistant Professor (1986); PhD, Scripps Institution of Oceanography, 1985.

Jeffrey Dean Paduan, Assistant Professor (1991); PhD, Oregon State University, 1987.

Robert George Paquette, Adjunct Professor Emeritus (1971); PhD, University of Washington, 1941.

Steven Richard Ramp, Assistant Professor (1986); PhD, University of Rhode Island, 1986.

Chairman:
Curtis A. Collins
Professor
Code OC/Co, Spanagel Hall
Room 350
(408) 656-2673
DSN 878-2673

Associate Chairmen:

Research
Edward B. Thornton
Professor
Code OC/Tm, Spanagel Hall
Room 327
(408) 656-2847
DSN 878-2847

Academic Affairs
Roland W. Garwood, Jr.,
Professor
Code OC/Gd, Spanagel Hall
Room 308
(408) 656-3260
DSN 878-3260

Leslie K. Rosenfeld, Adjunct Research Professor (1989); PhD, Woods Hole Oceanographic Institution, 1987.

Peter Joshua Rovero, LCDR, U.S. Navy; Instructor (1991); MS, Naval Postgraduate School, 1984.

Albert Julius Semtner, Jr., Professor (1986); PhD, Princeton University, 1973.

Gary Duane Sharp, Adjunct Research Professor (1991), PhD, Scripps Institution of Oceanography, 1972.

Timothy Peter Stanton, Adjunct Research Professor (1978); MS, University of Auckland, 1977.

Warren Charles Thompson, Professor Emeritus (1953); PhD, Texas A & M University, 1953.

Edward Bennett Thornton, Professor and Associate Chairman for Research, (1969); PhD, University of Florida, 1970.

Eugene Dewees Traganza, Professor Emeritus (1970); PhD, University of Miami, 1966.

Stevens Parrington Tucker, Adjunct Teaching Professor (1968); PhD, Oregon State University, 1972.

Joseph John von Schwind, Professor Emeritus (1967); PhD, Texas A & M University, 1968.

Jack B. Wickham, Professor Emeritus (1951); MS, Scripps Institution of Oceanography, 1949.

James H. Wilson, Adjunct Research Professor (1992); PhD, The Pennsylvania State University, 1974.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Oceanography Department primarily supports curricula sponsored by the Oceanographer of the Navy, #373 Air-Ocean Science, #374 Operational Oceanography, #440 Oceanography.

The department focuses on Physical Oceanography, Acoustical Oceanography and Nearshore and Coastal Oceanography.

Topics include ocean dynamics, numerical ocean circulation modeling, satellite remote sensing of the ocean, air-sea interaction, Arctic oceanography, upper ocean dynamics and thermodynamics, near-shore processes, mesoscale dynamics, synoptic/mesoscale ocean prediction, coastal ocean circulation and environmental acoustics. Courses are also offered in electronic navigation, marine geodesy, marine geophysics, Naval astronomy and precise time. The department also provides core courses for Naval Intelligence, ASW, Engineering Acoustics and the Space curricula.

MASTER OF SCIENCE IN PHYSICAL OCEANOGRAPHY

Entrance to a program leading to the degree Master of Science in Physical Oceanography requires a baccalaureate degree. Minimal requirements include mathematics through differential and integral calculus and one year of calculus-based physics.

The degree Master of Science in Physical Oceanography requires:

1) Completion of at least eight physical oceanography graduate courses with at least four courses in the OC4000 series. The entire sequence of courses selected must be

approved by the Department of Oceanography. Significant educational experience at sea on a research vessel is required for the degree. (OC3570 satisfies this requirement).

2) Completion of an acceptable thesis on a topic approved by the Department of Oceanography.

MASTER OF SCIENCE IN METEOROLOGY AND PHYSICAL OCEANOGRAPHY

Direct entrance to a program leading to the degree Master of Science in Meteorology and Physical Oceanography requires a baccalaureate degree in one of the physical sciences, mathematics, or engineering. This normally permits the validation of a number of required undergraduate courses such as physics, differential equations, linear algebra, vector analysis and various courses in meteorology and/or oceanography, which are prerequisites to the graduate program. These prerequisites may be taken at the Naval Postgraduate School; however, in that event the program may be lengthened by one or more quarters.

The degree Master of Science in Meteorology and Physical Oceanography requires:

1) Necessary prerequisite courses in mathematics (through partial differential equations), meteorology and physical oceanography.

2) The sequence of core courses in meteorology and oceanography in the fields of dynamical, numerical and physical and synoptic meteorology and oceanography.

3) An approved selection of graduate elective courses in meteorology and oceanography.

4) A significant educational experience at sea or a research vessel.

5) An acceptable thesis on a topic approved by either department.

The total number of quarter hours in (2) and (3) above must be at least 48. These 48 hours must include 20 hours at the 4000 level in courses other than directed study and they should show an approximate balance between the disciplines of Meteorology and Physical Oceanography.

DOCTOR OF PHILOSOPHY

Department of Oceanography admission requirements for the degree Doctor of Philosophy include:

1) A master's degree (or the equivalent) in one of the physical sciences, mathematics, or engineering or,

2) A bachelor's degree with a high QPR or,

3) A highly successful first graduate year in a Master's program, with clear evidence of research ability.

The Ph.D. Program is in Physical Oceanography, including areas of study in ocean circulation theory, air-sea interaction, ocean acoustics and nearshore oceanography among others.

To undertake doctoral work in oceanography, a student must apply to the Chairman, Department of Oceanography. A copy of the Oceanography Ph.D. Program Guidelines is available from the Department of Oceanography.

OCEANOGRAPHIC LABORATORIES

NPS is a member of UNOLS (University National Oceanography Laboratory System) and of CENCAL (Central California Cooperative). UNOLS operates the Nation's academic

oceanographic research fleet, while CENCAL promotes and coordinates research vessel operations between several academic institutions in Central California. The nearby Moss Landing Marine Laboratory operates the NSF-owned, 135-foot R/V POINT SUR for the benefit of CENCAL. Through sponsorship of the Oceanographer of the Navy, NPS is a major user of the R/V POINT SUR, for both instruction and research.

A Physical Ocean Observation Laboratory (POOL) provides for instruction in the practical design, deployment and recovery of state-of-the-art oceanographic instrumentation. Real-time observations of currents, temperature, salinity and sound velocity structure in a variety of oceanic regimes are analyzed, applying theoretical and mathematical techniques learned in the classroom to Naval Oceanography problems.

NPS is also a member of UCAR (University Corporation for Atmosphere Research), which serves some of the computational and other research facility needs of the oceanographic community. Together with the Meteorology Department, the Oceanography Department operates the Interactive Digital Experimental Analysis Laboratory (IDEA) that is equipped with several workstations for the analysis of satellite images or other digital fields, e.g., numerical model output. In addition, the Department operates 12 networked mix workstations for simulation and analysis of oceanographic data.

The Department is organized around thematic laboratories; each containing faculty, staff and student offices, computing facilities and special laboratory equipment. Thematic laboratories exist for Oceanic Planetary Boundary Layer, Polar, Nearshore, Acoustics, and Electronics and Calibration.

COURSE OFFERINGS

OC0810 THESIS RESEARCH (0-0).
Every student conducting research in Oceanography will enroll in this course.

OC0999 THESIS SEMINARS (NO CREDIT) (2-0).
Students in the various oceanography curricula present their thesis research. PREREQUISITE: Preparation of a thesis.

OC2020 COMPUTER COMPUTATIONS IN AIR-OCEAN SCIENCES (1-2).
Introduction to FORTRAN and the NPS mainframe computer, as applied to elementary problems in oceanography and meteorology. PREREQUISITES: Calculus and college physics.

OC3120 BIOGEOCHEMICAL PROCESSES IN THE OCEAN (4-3).
Basic biological, geological, and chemical processes in the ocean. Bioacoustics, deep scattering layers, and bio-deterioration. Geomorphic features of the ocean floor; kinds and distribution of ocean bottom features. Chemical composition of the ocean.

OC3140 PROBABILITY AND STATISTICS FOR AIR-OCEAN SCIENCE (3-2).
Basic probability and statistics, in the Air-Ocean Science context. Techniques of statistical data analysis. Structure of a probability model, density distribution function, expectation, and variance. Binomial, Poison and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. Histograms and empirical distributions and associated characteristics such as moments and percentiles. Standard tests of hypotheses and confidence intervals for both one- and two-parameter situations. Regression analysis as related to least squares estimation. PREREQUISITE: Calculus.

OC3150 ANALYSIS OF AIR OCEAN TIME SERIES (3-2). Analysis methods for atmospheric and oceanic time series. Furrier transforms applied to linear systems and discrete data. Correlation functions, power density spectra and cospectra. Optimal design of air-ocean data network. Laboratory work involves analysis of actual atmospheric and ocean time series using principles developed in class. PREREQUISITES: MA3132 and a probability and statistics course.

OC3210 POLAR OCEANOGRAPHY (3-0).
Covers the ice characteristics and physical oceanography of polar seas. Sea ice: types, physical and mechanical properties, heat flux, temporal and spatial distribution, melting and freezing processes, forecasting models and remote sensing of ice/snow covered surfaces. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polyna processes and underwater acoustics. Naval and research operations in polar warfare. PREREQUISITE: OC3240

OC3212 POLAR METEOROLOGY/OCEANOGRAPHY (4-0).
Operational aspects of Arctic and Antarctic meteorology including Polar Lows, boundary layer, and marginal ice zone influences. Polar oceanography. Sea ice amount, seasonal distribution, melting and freezing processes, physical and mechanical properties, drift and predictions. Physical oceanography of currents and water masses, deep and bottom water formation, fronts and eddies, polyna processes. PREREQUISITES: MR3222 and OC3240 or consent of instructor.

OC3230 DESCRIPTIVE PHYSICAL OCEANOGRAPHY (3-1).
Physical properties of seawater. Processes influencing the distribution of heat, salt and density in the ocean. Static stability in the ocean. Circulation and water masses in the ocean. Laboratory work involves at sea collection and analysis of actual data using principles developed in class. PREREQUISITE: MR/OC2020 or the equivalent (may be concurrent).

OC3240 OCEAN DYNAMICS I (4-2).
Application of dynamical concepts of ocean circulation, including conservation of mass, momentum and energy. Oceanic currents without friction: inertial and geostrophic flows. Frictional currents: Reynolds equations, Ekman and wind-driven flows. Vorticity balance: Sverdrup transport, potential vorticity, topographic steering, western intensification, and Rossby waves. Thermohaline effects and thermocline theory. PREREQUISITES: OC3230 and OC3321 or the equivalent.

OC3260 SOUND IN THE OCEAN (4-0).
The fundamentals of ocean acoustics including the acoustic wave equation, ray tracing, acoustic arrays and filters, ambient noise, scattering, absorption and an introduction to normal mode theory. Examples from acoustical oceanography including ocean tomography, flow visualization and acoustic probing of the ocean surface and bottom.
PREREQUISITES: OC3230 and MA3132 or equivalent.

OC3261 OCEANIC FACTORS IN UNDERWATER SOUND (4-2).
Examines the oceanic factors which influence sound propagation in the ocean and the effects in acoustic forecasting. Factors considered include temporal and spatial variations in sound speed profiles, ambient noise, biological effects, reflection characteristics of ocean surface and bottom, signal fluctuations, and forecasting ocean thermal structure, transmission loss, ambient noise and reverberation. This course is designed for the Engineering Acoustics Curriculum. PREREQUISITE: PH3452.

OC3266 OPERATIONAL ACOUSTIC FORECASTING (3-2).
Course emphasizes tactical use of the environment as a force multiplier in acoustic ASW. Tactical guides involving ducts, fronts, eddies and bottom structure are examined in range-dependent propagation loss mode. Emerging tactics using LFA, VLF and Fixed Distributed systems and non-acoustic methods are reviewed. PREREQUISITES: OC4267, SECRET NOFORN clearance.

OC3321 AIR-OCEAN FLUID DYNAMICS (4-0).
The hydrodynamical equations for rotating stratified fluids. Forces, kinematics, boundary conditions, scale analysis. Simple balanced flows, baroclinicity, thermal wind, vorticity and divergence; rotational and divergent part of the wind; circulation theorem.
PREREQUISITE: MA2047.

OC3325 MARINE GEOPHYSICS (3-0).
Theory and methods of marine geophysics surveys, and emphasis on gravity, magnetism, seismic and acoustic wave propagation; geophysical anomalies associated with major seafloor features; marine geodesy. PREREQUISITE: MR2121 (may be concurrent).

OC3445 OCEANIC AND ATMOSPHERIC OBSERVATIONAL SYSTEMS (2-2).
Principles of measurement; sensors, data acquisition systems, calibration, etc. Methods of measurement for thermodynamic and dynamic variables in the ocean and atmosphere, including acoustics and optics. PREREQUISITES: OC3230 and MR3420, MR/OC3150 or consent of instructor.

OC3520 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN (4-0).
Principles of radiative transfer and satellite sensors and systems; visual, infrared and microwave radiometry, and radar systems; application of satellite remotely sensed data in the measurement of atmospheric and oceanic variability. PREREQUISITES: Undergraduate physics and differential/integral calculus; ordinary differential equations or consent of instructor.

OC3522 REMOTE SENSING OF THE ATMOSPHERE AND OCEAN/ LABORATORY (4-2).
Same as OC3520 plus laboratory sessions on the concepts considered in the lecture series. PREREQUISITES: Same as OC3520.

OC3570 OPERATIONAL OCEANOGRAPHY (2-4).
Experience at sea acquiring and analyzing oceanographic data using state-of-the-art instrumentation. Integration of satellite remote sensing and other operational products with in-situ data. Includes survey of instrumentation, pre-cruise planning, operations at sea, and post-cruise analysis. PREREQUISITE: OC3240 or MR3220 or consent of instructor.

OC3610 WAVE AND SURF FORECASTING (2-2).
Theory and prediction of wind-generated ocean waves. Spectral transformation of waves from deep to shallow water. Prediction of surf and wave related influences on operations. PREREQUISITES: OC3150 and OC4211.

OC3750 NAVAL ASTRONOMY AND PRECISE TIME (2-0).
Positional astronomy. Coordinate systems. Solar system dynamics. Astrometry (measurements of positions and motions of stars). Time, earth rotation and atomic clocks. Naval applications of astronomy. Overview of astrophysics and cosmology. PREREQUISITES: College physics and calculus.

OC3903 ELECTRONIC SURVEYING AND NAVIGATION (3-0).
Introduction to theory and practice of electronic navigation including principles of electronics, geometry, and propagation velocity. Covers ground based and satellite systems. **PREREQUISITE:** Consent of instructor.

OC4211 OCEAN DYNAMICS II (4-0).
Linear theory of surface, internal, inertial-internal and Rossby waves, barotropic and baroclinic instabilities. Coastal and equatorial trapped waves. PREREQUISITES: MA3132 and OC3240.

OC4212 TIDES (4-0).
Development of the theory of tides including the tide-producing forces, equilibrium tides, and the dynamic theory of tides; harmonic analysis and prediction of tides; tidal datum planes and their relationship with geodetic datum planes, short-term and secular changes in sea level. PREREQUISITE: OC3130 or OC4211.

OC4213 NEARSHORE AND WAVE PROCESSES (3-1).
Shoal-water wave processes, breakers and surf; nearshore water circulation; beach characteristics; littoral drift; coastal hydraulics; storm surge. PREREQUISITE: OC4211 or consent of instructor.

OC4220 COASTAL CIRCULATION (4-1).
Coastal ocean physical processes. Dynamics and models of coastal ocean circulations driven by wind, thermohaline, tidal, boundary currents and ocean eddy forces. Recent papers on coastal ocean circulation. Sessions on computing properties of coastal trapped waves and wind-driven motions over the shelf and slope. PREREQUISITE: OC4211.

OC4230 PHYSICAL OCEANOGRAPHY OF MONTEREY BAY (3-0)
Monterey Bay will be used as a case study for various processes affecting the physical oceanography of coastal environments. Topics to include coastal upwelling, flow in and around submarine canyons, internal waves, air-sea interactions, and tides and seiches. Historical, recent, and ongoing studies in and around the Bay will be considered. PREREQUISITE: OC4211 or consent of instructor.

OC4250 GENERAL CIRCULATION OF THE ATMOSPHERE AND OCEANS (3-0).
Selected topics on the general circulation of the atmosphere (e.g. heat, momentum and moisture fluxes; energetics) and ocean (e.g. linear and non-linear theories of the wind-driven ocean circulation); coupled ocean-atmosphere general circulation models. PREREQUISITE: Consent of instructor.

OC4262 THEORIES & MODELS IN UNDERWATER ACOUSTICS (3-0).
The second in a three-course sequence of underwater acoustics courses. Development of the underlying theories and algorithms of ray, normal mode, and parabolic equation acoustic models for both range independent and dependent environments. Examination of the strengths and weaknesses of and similarities between the various models. PREREQUISITES: OC3260, and MA3132 or equivalent.

OC4267 OCEAN ACOUSTIC PREDICTION (4-0).
Examines sound speed profiles (time and space variability), ambient noise, absorption, and reflection and scattering from the sea surface and bottom as they affect sound propagation in the ocean. Synoptic prediction techniques for ambient noise and transmission loss are reviewed. Environmental data input and computational approximations for acoustic models are evaluated against observed signal fluctuations and transmission loss. The course is designed for the Air-Ocean Science, Operational Oceanography, and ASW Curricula. PREREQUISITES: OC3230 and OC3260 or equivalent.

OC4323 NUMERICAL AIR AND OCEAN MODELING (4-2).
Numerical models of atmospheric and oceanic phenomena. Finite difference techniques for solving elliptic and hyperbolic equations, linear and non-linear computational instability. Spectral and finite element models. Filtered and primitive equation prediction models. Sigma coordinates. Objective analysis and initialization. Moisture and heating as time permits. PREREQUISITES: MR4322 or OC4211, MA3132; MA3232 desirable.

OC4324 ADVANCED NUMERICAL OCEAN MODELING (3-0).
Advanced techniques for simulating and predicting ocean circulation, including recent modeling results. Topics to include multi-layer guasi-geotrophic models, multi-level primitive equation models, treatment of irregular geometry and open boundary conditions, satellite data assimilation and computer technology considerations. PREREQUISITE: MR/OC 4323.

OC4331 MESOSCALE OCEAN VARIABILITY (4-0).
Contemporary knowledge of ocean mesoscale eddies, fronts, meandering currents; baroclinic and barotropic instabilities; kinematics, dynamics and energetics from observations, theories and models. PREREQUISITE: OC4211.

OC4335 ELEMENTS OF OCEAN PREDICTION (3-2).
Analyze, forecast, and interpret synoptic information on mesoscale, synoptic scale, and large scale processes on a regional basis. Use is made of dynamical and statistical principles and methods and of diagnostic and prognostic models. PREREQUISITES: OC4330 and MR/OC4323 (may be concurrent).

OC4413 AIR/SEA INTERACTION (4-1).
Fundamental concepts in turbulence. The atmospheric planetary boundary layer, including surface layer, and bulk formulae for estimating air-sea fluxes. The oceanic planetary boundary layer including the dynamics of the well-mixed surface layer. Recent papers on large-scale air-sea interaction. PREREQUISITE: MR/OC3150, OC3240 or MR4322, or consent of instructor.

OC4414 ADVANCED AIR/SEA INTERACTION (3-0).
Advanced topics in the dynamics of the atmospheric and oceanic planetary boundary layers. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4415 OCEAN TURBULENCE (3-0).
Advanced topics in the dynamics of ocean turbulence, wakes and microstructure. PREREQUISITE: MR/OC4413 or consent of instructor.

OC4490 OCEAN ACOUSTIC TOMOGRAPHY (OC4490, same as EC4490) (3-0).
An introduction to Ocean Tomography, an underwater acoustic inverse technique for mapping ocean sound speed and current fields. Covers the major aspects of Ocean Acoustic Tomography, including the underlying concepts, the design and transmission of tomographic signals, and linear inverse methods for the reconstruction of ocean fields. PREREQUISITES: OC3260 or EC3450 or PH4453 or equivalent; MA2042 and MA3132 or equivalent.

OC4520 TOPICS IN SATELLITE REMOTE SENSING (3-0).
Selected topics in the advanced application of satellite remote sensing to the measurement of atmospheric and oceanic variables. PREREQUISITE: MR/OC3522.

OC4610 RUSSIAN OCEANOGRAPHY (3-0).
Russian civilian and naval oceanography program including centers, research vessels, instrumentation, remote sensing, numerical modeling and current ocean research areas. Relation to naval strategy and operations. Recent Russian papers. PREREQUISITES: OC3240 or consent of instructor and SECRET NOFORN clearance.

OC4706 GEOMETRIC AND ASTRONOMIC GEODESY (4-0).
Properties of the ellipsoid, geometric aspects of geodesy including triangulation, trilateration, traverse, and leveling techniques and instrumentation; datum transformation, astronomic determination of latitude, longitude, and azimuth; time and astronomic instrumentation. PREREQUISITE: Consent of instructor.

OC4707 GRAVIMETRIC AND SATELLITE GEODESY (4-0).
Potential theory as applied to the gravity field of the earth; application of Stokes' Formula, integral, and function; deflection of the vertical; gravimetric reduction; geometric and dynamic applications of satellites, orbital geometry and satellite orbit dynamics. PREREQUISITE: OC4706.

OC4800 ADVANCED COURSES IN OCEANOGRAPHY (Variable hours 1-0 to 4-0) (V-).
Advanced courses in various aspects of oceanography. Typically these are advanced topics not covered in regularly offered courses. The course may be repeated for credit as topics change. PREREQUISITES: Consent of the department Chairman and instructor.

OC4900 DIRECTED STUDY IN OCEANOGRAPHY (V-0). Independent study of advanced topics in oceanography. PREREQUISITES: Consent of the department Chairman and instructor. Graded on Pass/Fail basis only.

DEPARTMENT OF OPERATIONS RESEARCH

Michael Page Bailey, Assistant Professor (1988)*; PhD, University of North Carolina, 1988.

Dan Calvin Boger, Professor (1979); PhD, University of California at Berkeley, 1979.

Gordon Hoover Bradley, Professor (1973); PhD, Northwestern University, 1967.

Gerald Gerard Brown, Professor (1973); PhD, University of California at Los Angeles, 1974.

Don Brutzman, LCDR, USN, Military Instructor (1992); MS, Naval Postgraduate School, 1992.

William Caldwell, LtCol, U.S. Army; Instructor (1989); MS, Naval Postgraduate School, 1981.

George Conner, Captain, USN, Chair of Tactical Analysis, Director of Military Faculty, (1991); MS, Naval Postgraduate School, 1982.

Robert F. Dell, Assistant Professor (1990); PhD, State University of New York at Buffalo, 1990.

James Norfleet Eagle, II, Chairman of Antisubmarine Warfare Academic Group, Professor (1982); PhD, Stanford University, 1975.

James Daniel Esary, Professor (1970); PhD, University of California at Berkeley, 1957.

Robert Neagle Forrest, Professor Emeritus (1964); PhD, University of Oregon, 1959.

Donald Paul Gaver, Jr., Distinguished Professor (1970); PhD, Princeton University, 1956.

Thomas Eugene Halwachs, Commander, U.S. Navy; Director of Wargaming (1988); MS, Naval Postgraduate School, 1976.

Douglas Hartman, CDR, USN, Military Instructor, (1991); MS, Naval Postgraduate School, 1982.

Gilbert Thoreau Howard, Associate Professor and Associate Dean of Research (1967); PhD, Johns Hopkins University, 1967.

Wayne Philo Hughes, Jr., Adjunct Professor (1979); MS, Naval Postgraduate School, 1964.

Patricia Anne Jacobs, Professor (1978); PhD, Northwestern University, 1973.

Chairman:
Peter Purdue
Professor
Code OR, Root Hall
Room 272
(408) 656-2381
DSN 878-2381

Associate Chairmen:

Operations
Thomas E. Halwachs
Instructor
Code OR/Ha, Root Hall
Room 265
(408) 656-2413
DSN 878-2413

Research
Robert R. Read
Professor
Code OR/Re, Root Hall
Room 259
(408) 656-2382
DSN 878-2382

Instruction
James D. Esary
Professor
Code OR/Ey, Root Hall
Room 273
(408) 656-2780
DSN 878-2780

William Glenn Kemple, Assistant Professor (1990); PhD, University of California at Riverside, 1985.

Harold Joseph Larson, Professor (1962); PhD, Iowa State University, 1960.

Siriphong Lawphongpaich, Associate Professor (1987); PhD, University of Florida, 1983.

Peter Adrian Walter Lewis, Distinguished Professor (1971); PhD, University of London, 1964.

Judith Harris Lind, Adjunct Professor (1985); MS, Naval Postgraduate School, 1985.

Glenn Frank Lindsay, Associate Professor (1965); PhD, Ohio State University, 1966.

Lewis Dot Madden, CAPT, U.S. Navy; Chair of Applied Systems Analysis (1991); MS, Naval Postgraduate School, 1977.

Kneale Thomas Marshall, Professor and Chair of Emerging Technologies (1968); PhD, University of California at Berkeley, 1966.

Barbara Y. Marsh-Jones, CDR, USN, Military Instructor, (1992); MS, Naval Postgraduate School, 1985.

Alan Wayne McMasters, Professor (1965); PhD, University of California at Berkeley, 1966.

Paul Robert Milch, Professor (1963); PhD, Stanford University, 1966.

Gordon Ross Nakagawa, Adjunct Professor, (1990); MS, Naval Postgraduate School, 1966.

Samuel Howard Parry, Professor (1964); PhD, Ohio State University, 1971.

Frank Petho, CDR, USN, Assistant Professor, (1991); PhD, University of Vermont, 1979.

Gary Kent Poock, Professor (1967); PhD, University of Michigan, 1967.

Peter Purdue, Chairman and Professor (1986); PhD, Purdue University, 1972.

Robert Richard Read, Professor (1961); PhD, University of California at Berkeley, 1957.

Victor W. Roeske, Maj, U.S. Army; Instructor (1989); MS, Rensselaer Polytechnic Institute, 1982.

Richard Edwin Rosenthal, Professor (1985); PhD, Georgia Institute of Technology, 1975.

David Alan Schrady, Professor (1965); PhD, Case Institute of Technology, 1965.

Bruno Otto Shubert, Associate Professor (1969); PhD, Stanford University, 1968.

So Young Sohn, Assistant Professor (1990); PhD, University of Pittsburgh, 1989.

Michael Graham Sovereign, Professor (1970); PhD, Purdue University, 1965.

James Grover Taylor, Professor (1968); PhD, Stanford University, 1966.

Eric S. Theise, Assistant Professor (1990); PhD, Northwestern University, 1988.

William John Walsh, LCDR, U.S. Navy; Instructor (1987); MS, Naval Postgraduate School, 1985.

Alan Robert Washburn, Professor and Associate Dean of Faculty and Graduate Studies (1970); PhD, Carnegie Institute of Technology, 1965.

Lyn R. Whitaker, Associate Professor (1988); PhD, University of California, Davis 1985.

Roger Kevin Wood, Associate Professor (1982); PhD, University of California, Berkeley, 1982.

Walter Max Woods, Professor (1962); PhD, Stanford University, 1961.

Peter William Zehna, Professor Emeritus (1961); PhD, Stanford University, 1959.

Alan D. Zimm, CDR, USN, Military Instructor (1991); Curricular Officer, MS, Naval Postgraduate School, 1983.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

The Operations Research Department was founded in 1961 primarily to service students in the OA (360) Curriculum. Graduates of that curriculum receive the Master of Science in Operations Research degree as do graduates of the recently inaugurated Operational Logistics (361) Curriculum. The department consists of approximately forty faculty located in Root Hall. The department operates three laboratories: the Man/Machine Systems Design Lab on the first floor of Root Hall, the Wargaming Lab in Ingersoll Hall and the Microcomputer Lab in Ro-262.

In addition to being the primary department for the 360 and 361 curricula, the Operations Research Department also provides an extensive sequence of service courses for students in other curricula and is charged with teaching all probability and statistics courses at NPS. Nearly half of the department's teaching effort is devoted to these courses.

Active research areas within the department include statistics, stochastic processes, mathematical programming, human factors, wargaming, simulation, combat models, logistic systems, C3I systems, EW and ASW models.

MASTER OF SCIENCE IN APPLIED SCIENCE

Students with acceptable academic backgrounds may enter a program leading to a degree in Applied Science with a major in Operations Research. The program of each student seeking this degree must contain a minimum of 20 quarter hours in operations research at the graduate level, including work at the 4000 level. Additionally, the program must contain a minimum of 12 graduate quarter hours in an approved sequence of courses outside the Department of Operations Research. A total minimum of 12 quarter hours at the 4000 level plus an acceptable thesis is required. This program provides depth and diversity through specially arranged course sequences to meet the needs of the Navy and the interests of the individual. The Department Chairman's approval is required for all programs leading to this degree. Applications to include this degree in dual master's programs will not be approved.

MASTER OF SCIENCE IN OPERATIONS RESEARCH

The degree Master of Science in Operations Research requires that:

1. A candidate shall previously have satisfied the requirements for the degree Bachelor of Science in Operations Research or the equivalent.

2. Completion of a minimum of 40 quarter hours of graduate level courses with:

    a. At least 18 quarter hours of 4000 level operations research/systems analysis courses.

b. An elective sequence approved by the Department of Operations Research.

c. At least two, but not more than three, quarter courses devoted to a thesis. This credit shall not count toward the requirement as stated in (a) above.

3. Submission of an acceptable thesis on a subject previously approved by the Department of Operations Research.

DOCTOR OF PHILOSOPHY IN OPERATIONS RESEARCH

The department offers the Ph.D. degree in Operations Research. The program begins with advanced coursework guided by the student's doctoral committee and leading to qualifying examinations in mathematical programming, statistics and stochastic processes, as well as completion of a minor field of study outside of operations research. The primary emphasis then shifts to the student's research program culminating in the Ph.D. dissertation.

Students wishing to enter directly into the doctoral program should write to the department Chairman. Applicants should include transcripts, Graduate Record Examination (or equivalent) scores and a brief statement of purpose. Detailed admission procedures may vary depending on the individual's location and position. However, in all cases the student must fulfill the general school requirements for the doctor's degree. Residency for this program generally requires two to three years beyond completion of a master's degree.

COURSE OFFERINGS

OA0001 SEMINAR FOR OPERATIONS ANALYSIS STUDENTS (No Credit) (0-2).
Guest lecturers. Review of experience tours. Thesis and research presentations.

OA0200 INTRODUCTION TO COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH (No credit) (Meets last 6 weeks of quarter) (2-2).
Introduction to the Operations Research Department personal computer laboratory and software. DOS, editing, word processing, spreadsheets, data analysis, database and presentation graphics will be introduced. Introduction to timesharing on the mainframe. PREREQUISITES: None.

OA0810 THESIS RESEARCH FOR OPERATIONS ANALYSIS STUDENTS (0-0).
Every student conducting thesis research will enroll in this course.

OA2200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH I (4-0).
A first course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Primary emphasis on the planning and structuring of computer programs. In depth analysis of proper program logic flow, program listings and debugging techniques. Introduction to the Mathematical and Statistics subroutine libraries. Assigned projects involve file management, data structures and operations research models. PREREQUISITES: None.

OA2600 INTRODUCTION TO OPERATIONS ANALYSIS (4-0).
A first course in Operations Analysis, covering its origins in World War II to current practice. Introduces concepts, tools and methods of analysis, with tactical examples. Emphasis is on measuring combat effectiveness and developing better tactics. PREREQUISITES: None.

OA2900 WORKSHOP IN OPERATIONS RESEARCH / SYSTEMS ANALYSIS (Variable Credit) (V-0).
This course may be repeated for credit if course content changes. PREREQUISITE: Department approval. Graded on Pass/Fail basis only.

OA2910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0) (V-0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background in operations research.

OA3101 PROBABILITY (4-1).
Probability axioms and event probability. Random variables and their probability distributions. Moment generating functions, moments and other distribution characteristics, distribution families. Functions of a random variable, including the probability integral transformation. PREREQUISITE: MA1117 or equivalent.

OA3102 PROBABILITY AND STATISTICS (4-1).
Jointly distributed random variables, independence and conditional distributions, covariance and correlation. Functions of several random variables, sampling distributions, limiting distributions, the central limit theorem, approximations. Order statistics, the t and f distributions, the bivariate normal distribution. Point estimation, properties of estimators. PREREQUISITES: OA2200, OA3101 and MA1118 or equivalent; MA3110 taken concurrently.

OA3103 STATISTICS (4-1).
Confidence intervals, hypothesis testing, regression, analysis of variance and nonparametric inference. Applications to reliability, test and evaluation and operations research problems. PREREQUISITE: OA3102 or equivalent.

OA3104 DATA ANALYSIS (3-1).
Techniques of analyzing, summarizing and comparing sets of real data. The exploratory nature of data analysis is featured through a variety of plotting methods and interactive work on computer terminals. Includes model building and the discovery and overcoming of shortcomings in data collected in actual situations. PREREQUISITE: OA3103.

OA3105 NONPARAMETRIC STATISTICS (4-0).
Tests based on the binomial distribution; confidence intervals for percentiles, tolerance intervals and goodness-of-fit tests; contingency tables; one sample tests, two sample tests and tests for independence based on ranks and scores; nonparametric analysis of variance and regression. Applications will illustrate the techniques. PREREQUISITE: A course in statistical inference.

OA3200 COMPUTATIONAL METHODS FOR OPERATIONS RESEARCH II (4-0).
An advanced course in computer programming, with emphasis on the use of a higher level programming language directed toward computational methods particularly appropriate to operations research. Assigned projects involve advanced data structures, operations research models, numerical analysis, data analysis, basic complexity analysis, and computer simulation. PREREQUISITE: OA2200, or consent of instructor.

OA3201 LINEAR PROGRAMMING (4-1).
Theory of optimization of linear functions subject to linear constraints. The simplex algorithm, duality, sensitivity analyses, parametric linear programming. Applications to resource allocation, manpower planning, transportation and communications, network models, ship scheduling, etc. Introduction to computer-based linear programming systems. PREREQUISITES: MA2042, MA3110 and OA3200.

OA3301 STOCHASTIC MODELS I (4-0).
The homogeneous and inhomogeneous Poisson processes, filtered and compound Poisson processes. Stationary Markov chains and their applications in modeling random phenomena. PREREQUISITE: OA3101 or consent of instructor.

OA3302 OA SYSTEM SIMULATION (4-0).
Discrete event digital simulation methodology. Monte Carlo techniques, use of FORTRAN and other available simulation languages. Variance reduction techniques, design of

simulation experiments and analysis of results. PREREQUISITES: OA3200 or equivalent, OA3103 or equivalent, OA3301.

OA3401 HUMAN FACTORS IN SYSTEMS DESIGN I (4-0).
The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man's motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3402 HUMAN FACTORS IN SYSTEMS DESIGN II (3-0).
The human element in man-machine systems. Selected topics in human engineering and psychophysics with emphasis on their relation to military systems. Man-machine interface and man's motor and sensory capacities. PREREQUISITE: A course in statistics.

OA3501 INVENTORY I (4-0).
A study of deterministic and approximate stochastic inventory models. Deterministic economic lot size models with infinite production rate, constraints, quantity discounts. An approximate lot size-reorder point model with stochastic demand. An approximate stochastic periodic review model. Single period stochastic models. Applications to Navy supply systems. PREREQUISITE: OA3101 or consent of instructor.

OA3601 COMBAT MODELS AND GAMES (4-0).
This course provides a discussion of measures of effectiveness and a quantitative introduction to dynamic programming, target coverage models, Kalman filters, Lanchester Systems and two-person, zero-sum games. PREREQUISITES: MA3110, OA3102.

OA3602 SEARCH THEORY AND DETECTION (4-0).
Search and detection as stochastic processes. Characterization of detection devices, use and interpretation of sweep widths and lateral range curves, true range curves. Measures of effectiveness of search-detection systems. Allocation of search efforts, sequential search. Introduction to the statistical theory of signal detection. Models of surveillance fields, barriers, tracking and trailing. PREREQUISITE: OA3301.

OA3610 INTRODUCTION TO NAVAL LOGISTICS (4-0).
This course is designed to teach students the fundamental purposes, history and components of the naval logistics system. Logistics is introduced as a command function necessary for sustaining combat operations. Specific topics include logistics resources and processes, unit logistics, battle group logistics, in-theater support, strategic lift, the functions of the CONUS shore establishment and DoD acquisition in support of existing forces. At each level, existing programs and policies are discussed and evaluated in the context of the ability to support combat operations. PREREQUISITES: None.

OA3900 WORKSHOP IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (V-0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OA3910 SELECTED TOPICS IN OPERATIONS RESEARCH/SYSTEMS ANALYSIS (Variable hours 2-0 to 5-0) (V-0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITE: A background of advanced work in operations research. Consent of instructor.

OA4101 DESIGN OF EXPERIMENTS (3-1).
Theory and application of the general linear hypothesis model. Analysis of variance and analysis of covariance. Planning experiments, traditional and hybrid experimental designs. Use of standard computer packages for analysis of experimental data. PREREQUISITE: OA3103 or equivalent.

OA4102 REGRESSION ANALYSIS (4-0).
Construction, analysis and testing of regression models. An in-depth study of regression and its application in operations research, economics and the social sciences. PREREQUISITES: OA3102, OA3103 and OA3104.

OA4103 ADVANCED PROBABILITY (3-0).
Probability spaces, random variables as measurable functions, expectation using the Lebesque Stieltjes integral and abstract integration. Modes of convergence, characteristic functions, the continuity theorem, central limit theorems, the zero-one law. Conditional expectation. PREREQUISITE: MA3605 or departmental approval.

OA4104 ADVANCED STATISTICS (3-0).
Foundations of statistics from a decision-theoretic viewpoint. Robust estimation techniques, biased estimation. Fisher and Kullback information, asymptotic methods. Sufficiency, completeness, the Cramer-Rao inequality. Sequential tests, empirical Bayes tests. Statistical computation methods. PREREQUISITES: OA3103 and consent of instructor.

OA4201 NONLINEAR PROGRAMMING (4-0).
Introduction to modern optimization techniques, Karesh-Kuhn-Tucker necessary and sufficient conditions for optimality, quadratic and separable programming, basic gradient search algorithms and penalty function methods. Applications to weapons assignment, force structuring, parameter estimation for nonlinear or constrained regression, personnel assignment and resource allocation. PREREQUISITES: OA3201 and MA3110.

OA4202 NETWORK FLOWS AND GRAPHS (4-0).
Introduction to formulation and solution of problems involving networks. Elements of graph theory, data structures, search algorithms, max-flow mincut theorem, shortest route problems, minimum cost flows and PERT/CPM. Applications to production and inventory, routing, scheduling, network interdiction and personnel management. PREREQUISITE: OA3201.

OA4203 MATHEMATICAL PROGRAMMING (4-0).
Advanced topics in linear programming, large scale systems, the decomposition principle, additional algorithms, bounded variable techniques, linear fractional programming, formulation and solution procedures for problems in integer variables. Applications to capital budgeting, large scale distribution systems, weapon systems allocation and others. PREREQUISITE: OA3201.

OA4204 GAMES OF STRATEGY (4-0).
Mathematical models of conflict situations, emphasizing the theory of decision making against a completely opposed enemy. Topics include matrix games, Blotto games, stochastic games and the Shapley value. Applications to combat, resource allocation, cost sharing, etc. PREREQUISITES: OA3201 and OA3101 or consent of instructor.

OA4205 ADVANCED NONLINEAR PROGRAMMING (4-0).
Continuation of OA4201. Advanced topics in non-linear programming including duality theory, further consideration of necessary and sufficient conditions for optimality, additional computational methods examination of recent literature in non-linear programming. PREREQUISITE: OA4201.

OA4206 DYNAMIC PROGRAMMING AND OPTIMAL CONTROL (4-0).
The basic theory, including Bellman's equation and the Maximum Principle. Applications to tactical and economic problems. PREREQUISITE: OA3201.

OA4301 STOCHASTIC MODELS II (3-2).
Course objectives are to teach methods of stochastic modeling beyond those taught in OA3301 and to give students an opportunity to apply these tools to real world problems. Suitably selected projects that entail data collection and analysis are undertaken, with emphasis on problem formulation, choice of appropriate assumptions and attainment of practical results. Topics include renewal processes and further topics in queuing, illustrated by several military and industrial applications. PREREQUISITES: OA3301, OA3302 and OA3104.

OA4302 RELIABILITY AND WEAPONS SYSTEM EFFECTIVENESS MEASUREMENT (4-0).
Component and system reliability functions and other reliability descriptors of system effectiveness. Relationships between system and component reliability. Point and interval estimates of reliability parameters under various life testing plans. PREREQUISITE: OA3301.

OA4303 SAMPLE INSPECTION AND QUALITY ASSURANCE (4-0).
Attribute and variables sampling plans. MILSTD sampling plans with modifications. Multi-level continuous sampling plans and sequential sampling plans. Structure and implementation of quality assurance programs and analysis of selected quality assurance problems. PREREQUISITE: OA3101 or consent of instructor.

OA4304 DECISION THEORY (3-0).
Basic concepts, Bayes, admissible, minimax and regret strategies. Principles of choice. Relation of statistical decision functions to the theory of games. Application in the planning of operational evaluation trials. PREREQUISITE: OA3103.

OA4305 STOCHASTIC MODELS III (4-0).
Lecture topics include, non-stationary behavior of Markov processes, point process models, regenerative processes, Markovian queuing network models and non-Markovian systems. Applications to include reliability, computer system modeling, combat modeling and manpower systems. Students are given exercises entailing data analysis, formulation of probability models and application of models to answer specific questions concerning particular phenomenon. PREREQUISITES: OA3104, OA3301 and OA4301.

OA4306 STOCHASTIC PROCESSES I (4-0).
A selection of topics from the Kolmogorov theorem, analytic properties of sample functions, continuity and differentiability in quadratic mean, stochastic integrals, stationary processes, non-stationary processes, martingale limit theorems, the invariance principle, Markov and Gaussian processes. PREREQUISITE: OA4103.

OA4307 STOCHASTIC PROCESSES II (4-0).
A continuation of OA4306. PREREQUISITE: OA4306.

OA4308 TIME SERIES ANALYSIS (4-0).
Second order stationary processes. Harmonic analysis of correlation functions. Filters and spectral windows. Ergodic properties. Problems of inference in time series analysis. Box-Jenkins techniques. Introduction to the analysis of multivariate processes. PREREQUISITES: OA3301 and OA3104.

OA4321 DECISION SUPPORT SYSTEMS (3-1).
An introduction to the topic; includes an overview of organizational decision making, discussion of OR techniques integral to DDS, relationships to artificial intelligence and expert systems, specialized computer languages and non-traditional techniques for handling uncertainty. Current operational systems, both military and civilian, will be used as examples. PREREQUISITES: OA3200 and OA3101 or consent of instructor.

OA4333 SIMULATION METHODOLOGY (4-0).
Advanced techniques of model development and simulation experimentation. Discussion of current research. Actual topics selected will depend on interests of students and instructor. PREREQUISITE: OA3302.

OA4401 HUMAN PERFORMANCE EVALUATION (4-0).
Experimental considerations, strategy and techniques in evaluation of human performance characteristics and capabilities. Detailed examination of special methods to include multivariate designs, psychophysiological methods. Review of important variables affecting human performance and criteria, measures of effectiveness and figures of merit as indicants of performance quality. PREREQUISITE: OA3401.

OA4402 SKILLED OPERATOR PERFORMANCE (3-2).
First part of the course is devoted to an examination of the theoretical foundations of skilled performance. The second half of the course is devoted to the study of the acquisition, development and prediction of skilled operator performance in the operational setting. PREREQUISITE: OA3401.

OA4404 OPERATIONS RESEARCH IN MAN-MACHINE SYSTEMS (4-0).
Application of operations research techniques to man-machine design and evaluation problems. Quantitative methods for performance will be treated using such concepts as reliability, information theory and signal detection theory. A portion of the course is devoted to summarizing approaches to real world problems incorporating current methods from the literature. PREREQUISITES: OA3401, OA3201, OA3301 and OA4301 (may be taken concurrently).

OA4501 SEMINAR IN SUPPLY SYSTEMS (4-0).
A survey of the supply system for the U.S. Navy. Topics include the inventory models at all levels for consumables and repairables, budget formulation and execution, provisioning and allowance lists, planned program requirements, transaction item reporting and current topics of research such as stock migration and material distribution studies. PREREQUISITE: OA3501.

OA4502 INVENTORY II (4-0).
A study of stochastic inventory models. Single period models with time dependent costs, constrained multiple item single period models, deterministic and stochastic dynamic inventory models, the periodic review model, the Q-1 continuous review model. PREREQUISITES: OA3301 and OA3501.

OA4602 CAMPAIGN ANALYSIS (4-0).
The development, use and state-of-the-art of maritime campaign analysis. Emphasis is on formulating the analysis, measures of effectiveness, handling assumptions and parametric evaluations. Communicating results in speech and writing is an important part of the course. Students conduct a project as study team members. They research and report on major portions of major U.S. Navy analyses. PREREQUISITES: OA3103, OA3302, OA3601, OA3602, OA4604 and SECRET NOFORN clearance.

OA4603 TEST AND EVALUATION (3-2).
This course relates the theory and techniques of operations research to the problems associated with test and evaluation. Specific examples of exercise design, reconstruction and analysis are examined. PREREQUISITE: OA3104.

OA4604 WAR GAMING ANALYSIS (4-0).
Analysis of problems in the design, construction and application of manual, computer and interactive gaming. Emphasis is on gaming as a means of evaluating Naval Warfare tactics. NWISS and NAVTAG gaming facilities will be used. PREREQUISITES: OA3302 and SECRET NOFORN clearance.

OA4605 OPERATIONS RESEARCH PROBLEMS IN NAVAL WARFARE (3-0).
Analysis of fleet exercises. Changes in tactics and force disposition arising from the introduction of nuclear weapons and missiles. Relationship of air defense to strike capability and ASW. Current radar, sonar, communications and ECM problems. PREREQUISITES: OA3601 and OA4604.

OA4606 APPLICATIONS OF SEARCH, DETECTION AND LOCALIZATION MODELS TO ASW (3-0).
Applications of search, detection and localization models to search planning, target localization and tracking procedures and ASW sensor evaluation. Both acoustic and non-acoustic ASW sensors are considered. PREREQUISITES: OS3601 or OA4604 and SECRET NOFORN clearance.

OA4607 TACTICAL DECISION AIDS (3-2).
An in-depth review of modern Naval Tactical Decision Aids, particularly those involving computers. JOTS, ITDA, TESS and a variety of search planning aids. Principles of organization, computation, display and testing. Project required. PREREQUISITES: OA3602, OS3601, or consent of instructor.

OA4608 SOVIET MILITARY OPERATIONS RESEARCH (4-0).
This course provides an introduction to Soviet military operations research, with an emphasis on asymmetries in Soviet and American use of military OR. It will focus on how OR influences Soviet military theory and practice. It will begin by examining the Soviet military mind as influenced by the Russian/Soviet historical experience, Marxist-Leninist ideology and Soviet social and military institutions. It will then trace the historical development of military OR in the Soviet Union and discuss its nature today. Students will receive English translations of major Soviet works on military OR. PREREQUISITES: Course on combat modeling (e.g. OA3601 or OA4654) or consent of instructor and SECRET NOFORN clearance.

OA4610 MOBILIZATION (4-0).
Introduction to the military and civilian systems for mobilization, linear programming and simulation formulations of strategic mobility and munitions scheduling. Planning and controls of the logistics systems, including planning factors and joint operations planning. Integration of mobilization with Navy operational logistics.

OA4611 LOGISTICS IN NAVAL WARFARE (4-0).
This course is designed to teach students the role of logistics and logisticians in war planning and strategy development. Students are introduced to the Joint Chiefs of Staff, the world wide military command system and the Joint Strategic Planning System (JSPS). They will work through development of plans using deliberate planning, Time-Phased Force Deployment Data (TPFDD) and logistic planning factors. Student will be introduced to the Maritime Strategy and Navy planning based on NWP-11. The Weapon system acquisition process is examined as it relates to planning. The transition to war and mobilization are discussed and the problems with current organizations are analyzed in this regard. Logistics in the Soviet Navy are examined. PREREQUISITES: OA3610 and MN4373 and SECRET NOFORN clearance.

OA4612 LOGISTICS MODELS (4-0).
Mathematical modeling of most of the processes in unit/battle group or battle force logistics. Computation of fuel consumption, underway replenishment scheduling, shuttle ship requirements, measures of effectiveness, formations and their supportability, sustainability, engagement models and ordnance prediction and implementation of such models in microprocessor-based logistics decision aids. Also ordinance programming models. Only for US students enrolled in curricula 360 or 361. PREREQUISITE: Consent of instructor.

OA4654 AIRLAND COMBAT MODELS I (4-0).
Introduction to modeling air/ground combat operations with emphasis on detailed approaches for modeling small-scale combat. Topics include: types of models, the modeling process, verification, target acquisition models, target selection, weapon accuracy, lethality models, terrain effects, tactical decision making and integration of these models into large scale simulation models of combat. Models currently in use in DoD analysis are used as examples throughout the course. PREREQUISITE: OA3301.

OA4655 AIRLAND COMBAT MODELS II (4-0).
Modeling of large scale air/ground combat operations using aggregated force on force combat models. Topics include: Aggregation and disaggregation, types of models used for large scale operations, firepower index and Lanchester equation approaches to attrition modeling, movement rate of advance models, air warfare models and air allocation, logistics, C3 I process models, artificial intelligence applications. Models currently in use for DoD analysis are used as examples throughout the course. PREREQUISITE: OA3301 or consent of the instructor.

OA4701 ECONOMETRICS (4-0).
Construction and testing of econometric models, analysis of economic time series and the use of multivariate statistical analysis in the study of economic behavior. PREREQUISITE: OA3103.

OA4702 COST ESTIMATION (4-0).
Advanced study in the methods and practice of systems analysis with emphasis on cost analysis; cost models and methods for total program structures and single projects; relationship of effectiveness models and measures to cost analysis; public capital budgeting of interrelated projects; detailed examples from current federal practices. PREREQUISITE: AS3611 or equivalent.

OA4703 DEFENSE EXPENDITURE AND POLICY ANALYSIS (4-0).
A presentation of the major components of defense budgeting and policy formulation from the standpoint of the three major institutions involved, the agency, the executive branch and Congress. The use of quantitative models of institutional behavior is emphasized when examining both individual institutions and the interaction between them. PREREQUISITE: AS3611.

OA4704 O/R TECHNIQUES IN MANPOWER MODELING (4-0).
The most frequently applied manpower models are studied including Markov chain and renewal models using grade and/or length of service categories. Statistical techniques to estimate relevant attrition and promotion rates from cohort and census data are also included in the course to provide both longitudinal and cross-sectional views of personnel systems. Career aspects are analyzed with respect to attrition, promotion opportunity and time to promotion in hierarchical systems with or without promotion zones. Examples emphasize the personnel systems of the military services. PREREQUISITES: OA3201, OA3301 and OA3103.

OA4910 SELECTED TOPICS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0) (V-0).
Presentation of a wide selection of topics from the current literature. This course may be repeated for credit if course content changes. PREREQUISITES: A background of advanced work in operations research and departmental approval.

OA4930 READINGS IN OPERATIONS ANALYSIS (Variable hours 2-0 to 5-0) (V-0).
This course may be repeated for credit if course content changes. PREREQUISITE: Departmental approval. Graded on Pass/Fail basis only.

OS0810 THESIS RESEARCH FOR C3 STUDENTS (0-0).
Every student conducting thesis research will enroll in this course.

OS2101 ANALYSIS OF EXPERIMENTAL DATA (4-0).
Introduction to statistical analysis of measurements and experimental data. Frequency distributions, graphical representation. Populations and sampling. Principle of least squares, estimation of mean and standard deviation. Curve fitting and regression, propagation of errors. Confidence intervals, tests and contingency tables. Elementary ANOVA. Relevant probabilistic concepts introduced as needed.

OS2102 INTRODUCTION TO APPLIED PROBABILITY FOR ELECTRICAL ENGINEERING (4-1).
First course in probability. Structure of a probability model, density, distribution functions, expectation and variance. Some basic models, binomial, Poisson and Gaussian distributions. Conditional probability and independence. Joint distributions, covariance and central limit theorem. Transformations of random variables. PREREQUISITE: MA1118 or equivalent.

OS2103 APPLIED PROBABILITY FOR SYSTEMS TECHNOLOGY (4-1).
First course in probability for students in operational curricula. Topics include classical

probability calculation, discrete and continuous random variables, basic probability distributions, introduction to modeling, expectation, variance, covariance and rudiments of discrete-time processes. Emphasis is on developing familiarity with basic concepts and computational skills rather than mathematical rigor. Problem session is used in part to refresh and reinforce necessary calculus topics. PREREQUISITE: MA1118.

OS2210 INTRODUCTION TO COMPUTER PROGRAMMING (4-1).
An introduction to the operation and programming of the mainframe computer and portable programmable computers used in the ASW Curriculum. The FORTRAN and BASIC languages are emphasized.

OS3001 OPERATIONS RESEARCH FOR COMPUTER SCIENTISTS (4-0).
An introduction to some methodology and techniques of operations research that are relevant to computer system performance modeling and specification. Topics include Poisson processes, reliability theory and queuing theory.

OS3002 OPERATIONS RESEARCH FOR NAVAL INTELLIGENCE (4-0).
This course provides an introduction to the approach and methods of operations research, with special emphasis on military applications of interest to intelligence. It focuses on the mathematical modeling of combat operations and considers intelligence aspects (particularly Soviet use of OR). Students develop basic skills in such modeling. Topics include: operational definitions, measurement of combat effectiveness, model validation/verification and models versus modeling. Also included are modeling of processes of target acquisition, fire assessment (kill probabilities and target coverage), tactical decision making and games.

OS3003 OPERATIONS RESEARCH FOR ELECTRONIC WARFARE (4-0).
This course deals with applications of quantitative models to operational electronic warfare problems, with the underlying idea being to make decisions by optimizing some measure of effectiveness (MOE). Topics covered include ESM, ECM/ECCM, strike warfare, ASMD and cost-effectiveness tradeoffs. PREREQUISITES: Calculus and OS2103.

OS3004 OPERATIONS RESEARCH FOR COMPUTER SYSTEMS MANAGERS (5-0).
A one-quarter survey of operations research techniques of particular interest to students in computer systems management. Model formulation, decision theory, linear programming, project management techniques, inventory models, queuing and simulation, reliability and maintainability. Examples will illustrate the application of these techniques to the management of computer systems. PREREQUISITES: MA2300 and OS3101.

OS3005 OPERATIONS RESEARCH FOR COMMUNICATIONS MANAGERS (4-0).
A one-quarter survey of operations research techniques of particular interest to students in communications management. Model formulation, decision theory, games, linear programming, network flows, CPM and PERT, reliability and maintainability, Queuing theory and systems simulation. PREREQUISITES: MA2300, OS3101 or OS3105.

OS3006 OPERATIONS RESEARCH FOR MANAGEMENT (4-0).
A survey of problem-solving techniques for operations research. Topics include decision theory, linear programming, models, project scheduling, inventory, queuing and simulation. PREREQUISITES: MA2300, OS3101 or OS3105.

OS3007 OPERATIONS RESEARCH METHODOLOGY (4-0).
Survey of operations research techniques not covered in OS3006. Topics may include simulation, search theory, extensions of combat models, network flows and Markov chains. PREREQUISITES: OS3106 and OS3006 concurrently.

OS3008 ANALYTICAL PLANNING METHODOLOGY (4-0).
A one-quarter survey of operations research techniques of particular interest to students in the C3 curriculum, with emphasis on model formation. Topics include linear and nonlinear programming, integer programming, networks, shop flow and project scheduling, decision analysis, queuing and simulation. PREREQUISITE: MA2300.

OS3101 STATISTICAL ANALYSIS FOR MANAGEMENT (4-1).
A specialized course covering the basic methods of probability and statistics with emphasis on managerial applications. The course includes applications of probability models, statistical inference and regression analysis. Computation for these applications are carried out on a computer, using commercial software packages. Topics in probability include the binomial, geometric, Poisson and normal distributions, risk and expected value. Parametric statistical techniques include significance testing and confidence intervals, together with point estimation of model parameters. Regression analysis includes simple linear regression and multiple regression, with estimation of parameters and tests of hypothesis and confidence intervals for regression coefficients and the variance of the error term. PREREQUISITE: College algebra.

OS3104 STATISTICS FOR SCIENCE AND ENGINEERING (4-0).
Acquaint the engineering student with the techniques of statistical data analysis with examples from quality control, life testing, reliability and sampling inspection. Histograms, empirical distributions and random variables are introduced along with their probability distributions and associated characteristics such as moments and percentiles. Following a brief introduction to decision making, standard tests of hypotheses and confidence intervals for both one and two parameter situations are treated. Regression analysis is related to least squares estimation and associated tests of hypotheses and confidence intervals are treated. PREREQUISITE: Calculus.

OS3105 STATISTICAL ANALYSIS FOR MANAGEMENT I (4-1).
The first of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Skills in numerical computation are developed in laboratory periods through the use of MINITAB. Emphasis in the lectures is placed on modeling problems and interpreting results. Those aspects of probability structure that are germane to distributions such as the binomial and normal. Standard topics of statistical inference for one and two variables are introduced in the settings of both hypothesis testing and confidence interval estimation. PREREQUISITE: MA2300.

OS3106 STATISTICAL ANALYSIS FOR MANAGEMENT II (4-1).
The second of a two-quarter course in the use of the tools of probability and statistics oriented toward management applications. Using the tools and skills developed in OS3105, the course consists of a general study of linear models. Analysis of variance for one and two way models is followed by simple linear and multiple regression including such topics as curve fitting, residual analysis and stepwise regression, along with correlation analysis. Again the computer is used as a tool to facilitate computations with emphasis on statistical packages for large databases, such as SPSS and SAS. The course concludes with a sampling of nonparametric procedures. PREREQUISITE: OS3105.

OS3301 SYSTEMS EFFECTIVENESS CONCEPTS AND METHODS (4-0).
An introduction to system reliability, maintainability and effectiveness analysis. Failure (repair) rates and mean times to failure (repair). Models for aging and completion. Block diagrams and fault trees. Life testing, availability, interval reliability and the synthesis of reliability, maintainability and effectiveness analysis. PREREQUISITES: OS3105 and OS3106.

OS3303 COMPUTER SIMULATION (4-1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to ASW problems. War gaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification, and validation on special purpose simulation and gaming languages. PREREQUISITES: OS2103, OS3604 or equivalent and a working knowledge of FORTRAN programming.

OS3401 HUMAN FACTORS ENGINEERING (3-0).
An introduction to human factors engineering for students in fields such as engineering. Designed to give the student an appreciation of man's capacities and limitations and how

these can affect the optimum design of the man-machines system. Emphasis on integration of human factors into the system development cycle considering such topics as manpower/personnel costs, control and display design, human energy expenditure, physiological costs and evaluation systems. PREREQUISITE: A previous course in probability and statistics.

OS3402 HUMAN FACTORS FOR ANTISUBMARINE WARFARE (3-1).
Course involves an examination of man's attentiveness and capability in the detection of changes in stimulus events over prolonged periods of observation. Topics to be covered include theories of vigilance; task, signal, subject and environmental influences on performance, physiological and psychological responses and vigilance performance measurement. This course is designed for the ASW curriculum. PREREQUISITE: None.

OS3403 HUMAN FACTORS IN ELECTRONIC WARFARE (3-1).
This course will provide the student with the ability to evaluate and predict human performance in specified operational environments. The effects of stress factors such as noise, temperature, motion, work load, etc., on various aspects of human performance will be studied. Students will identify the control and display requirements for an EW system and design a workspace to accommodate an EW data reduction/analysis system. PREREQUISITE: OS3604.

OS3404 MAN-MACHINE INTERACTION (3-2).
An introduction to the man-machine interface problems in C3. Information, display and human communication requirements for effective C3. Applied orientation with student receiving own computerized mailbox on the ARPANET enabling the student to experience message handling systems, query languages, computer to computer communications between the U.S. and Europe, command and control applications programs, file transfer between host computers, etc. PREREQUISITE: Enrollment in C3.

OS3601 SEARCH, DETECTION and LOCALIZATION MODELS (4-0).
An introduction to the decision problems associated with Navy detection systems. The relation of detection models to search and localization models, measures of effectiveness of search/detection systems and the optimum allocation of search effort are discussed. This course is designed for the ASW curriculum. PREREQUISITES: OS2103, PH2401 or consent of instructor and SECRET clearance.

OS3602 ASW COMBAT ANALYSIS (4-0).
This course deals with the analysis of ASW operations. Topics include the analysis of force integration and communications, combat attrition, system reliability, target tracking, target data fusion and system measures of effectiveness. The course is designed for the ASW curriculum PREREQUISITES: OS2103 and OS3601 or consent of instructor.

OS3603 SIMULATION AND WAR GAMING (3-1).
Design, implementation and use of digital simulation models will be covered with special emphasis on features common to C3 and EW problems. War gaming will be discussed and a game using the digital computer will be played and critiqued by the class. Exercise planning and analysis will be treated. Basic topics are explained including computer generation of random variates, statistical design and monitoring of model progress, machine representation of dynamic data structures, model verification and validation on special purpose simulation and gaming languages. PREREQUISITES: OS2103, OS3604 or equivalent and a working knowledge of FORTRAN programming and SECRET clearance.

OS3604 DECISION AND DATA ANALYSIS (4-0).
This course provides an introduction to the techniques of decision analysis, statistics and data analysis. It is primarily for students in the ASW, EW and C3 curricula. Emphasis is placed on the analysis of data and decision making in the ASW, EW and C3 environments. PREREQUISITE: OS2103 or equivalent.

OS3636 ARCHITECTURE OF C3I SYSTEMS (4-0).
This course is primarily intended for students in the command and control program. It provides on introduction to the evaluation and modeling of Command, Control,

Communications and Intelligence (C3I) systems, with an emphasis on the comparative anatomy of Blue and Red systems and Operational Intelligence. The student is introduced to concepts pertaining to the design, functioning and evaluation of such large-scale systems and their architecture. PREREQUISITES: U.S. citizenship and TOP SECRET clearance with eligibility for SBI.

OS3637 SOVIET OPERATIONS AND SYSTEMS (4-0).
This course is intended for students in any of the operational curricula (but primarily the C3 program). It provides an introduction to Soviet thinking, conceptualization of military affairs, systems and operations. Soviet control concepts, including troop control, control of combat means and the role of automation, are emphasized. The systems approach to integrating different types of intelligence data to support U.S. defense (including command) decision making is considered. The course stresses the understanding of Soviet key words and concepts in military affairs. PREREQUISITES: U.S. citizenship and TOP SECRET clearance with eligibility for SI/SAO.

OS3702 MANPOWER REQUIREMENTS DETERMINATION (4-0).
The objective is to enable the student to use some of the tools of industrial engineering in the determination of the quantity and quality of manpower required in military systems. Techniques include motion and time study, work sampling, predetermined time standards, work design and layout, materials handling, procedures review and process design. Applications for ship and squadron manning documents and SHORESTAMPS are included. PREREQUISITES: OS3006, or OA3201 and OA3301.

OS4601 TEST AND EVALUATION (4-0).
Designed for system technology students, this course examines problems associated with tests and evaluations of weapon systems and tactics. Included are concepts from experimental design, regression analysis. Realistic data sets and examples are discussed and analyzed. PREREQUISITE: Inferential statistics.

OS4602 C3 SYSTEMS EVALUATION (2-4).
This course is designed for Systems Technology students in the Command, Control and Communications Curriculum. The course deals with techniques for the design, implementation and analysis of experiments or exercises aimed at the test and evaluation of systems, tactics or operational concepts. Course topics include modeling, experimentation methodology, design of experiments, multi-criteria decision analysis, reliability and man-machine interaction. Case studies and real data will be examined and students will actively participate in evaluations through laboratory experiments. PREREQUISITES: OS3008, OS3603, OS3604 and SECRET NORFORN clearance.

OS4701 MANPOWER AND PERSONNEL MODELS (4-0).
The objective of this course is to introduce the student to the major types of manpower and personnel models for estimating the effects of policy changes on the personnel system. Topics include longitudinal and cross-section models, optimization models, data requirements and validation. Applications in the form of current military models are included. PREREQUISITES: OS3006 and OS3106.

DEPARTMENT OF PHYSICS

Chairman:
Karlheinz E. Woehler
Professor
Code PH/Wh, Spanagel Hall
Room 100
(408) 656-2896
DSN 878-2896

Associate Chairmen:

Administration
William B. Zeleny
Associate Professor
Code PH/Zl, Spanagel Hall
Room 206C
(408) 656-2952
DSN 878-2952

Instruction
Robert L. Armstead
Associate Professor
Code PH/Ar, Spanagel Hall,
Room 112
(408) 656-2125
DSN 878-2125

Robert Louis Armstead, Associate Professor (1964)*; PhD, University of California at Berkeley, 1964.

Anthony A. Atchley, Associate Professor (1985); PhD, University of Mississippi, 1985.

Steven Richard Baker, Associate Professor (1985); PhD, University of California at Los Angeles, 1985.

David Dempster Cleary, Assistant Professor (1988); PhD, Colorado, 1985.

William Boniface Colson, Professor (1989); PhD, Stanford University, 1977.

Alfred William Madison Cooper, Professor (1957); PhD, The Queen's University of Belfast, 1961.

Alan Berchard Coppens, Associate Professor (1964); PhD, Brown University, 1965.

Harvey Arnold Dahl, Assistant Professor (1964); PhD Stanford University, 1963.

David Scott Davis, Associate Professor (1989); PhD, Purdue University, 1976.

Steven Lurie Garrett, Professor (1982); PhD, University of California at Los Angeles, 1977.

Suntharalingam Gnanalingam, Adjunct Professor (1985); PhD, Cambridge University, 1954.

Otto Heinz, Professor (1962); PhD, University of California at Berkeley, 1954.

Dan Howard Holland, Adjunct Professor (1990); PhD Stanford University, 1955.

Robert Mitchell Keolian, Assistant Professor (1990); PhD, University of California at Los Angeles, 1985.

Milton David Kite, Instructor (1991); MS, Naval Postgraduate School, 1988.

Xavier K. Maruyama, Professor (1987); PhD, Massachusetts Institute of Technology, 1971.

John Robert Neighbours, Professor (1959); PhD, Case Institute of Technology, 1953.

Richard Christopher Olsen, Associate Professor (1987); PhD, University of California at San Diego, 1980.

James Vincent Sanders, Associate Professor (1961); PhD, Cornell University, 1961.

Gordon Everett Schacher, Dean of Faculty and Graduate Studies, Professor (1964); PhD, Rutgers, 1961.

Fred Richard Schwirzke, Professor (1967); PhD, University of Karlsruhe, 1959.

Donald Lee Walters, Associate Professor (1983); PhD, Kansas State University, 1971.

Oscar Bryan Wilson, Jr., Professor (1957); PhD, University of California at Los Angeles, 1951.

Karlheinz Edgar Woehler, Chairman and Professor (1962); PhD, University of Munich, 1962.

William Bardwell Zeleny, Associate Professor (1962); PhD, Syracuse University, 1960.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

Expertise in the Department of Physics and efforts in research and teaching of graduate specialization courses for the last twenty years can be summarized under the heading "physics of propagation phenomena in realistic, complex environments". Specialized course sequences are offered in the following areas:

1) Optical Signal Propagation and Detection.
2) Directed Energy Weapons Systems.
3) Nuclear Weapons and their Effects.
4) Underwater Acoustics.
5) Physics of the Space and Satellite Environments.
6) Simulation of Large Scale Systems.
7) Physical Acoustics.

All of these specializations are of obvious relevance to modern and future weapons technologies. The faculty supports an ongoing research program in these areas and student thesis topics are available in all of them.

DEGREE REQUIREMENTS

The Department of Physics offers the Master of Science degree in Physics, in Applied Physics, and in Engineering Science. In addition, the Ph.D. is offered by the department. Upon approval by the department, courses taken at other institutions may be applied toward satisfying degree requirements.

MASTER OF SCIENCE IN PHYSICS

A candidate for the degree Master of Science in Physics must complete satisfactorily a program of study which includes a minimum of 30 quarter hours of physics courses (not including thesis) distributed among courses at the graduate (3000 or 4000) level; of these 30 hours at least 15 hours must be at the 4000 level. Upon approval of the Chairman of the Physics Department, a maximum of 4 hours of courses taken in another department may be applied toward satisfying the above requirements. In lieu of the preceding requirements, students who are qualified to pursue graduate courses in physics when they arrive at the Naval Postgraduate School may complete a minimum of 20 hours entirely of 4000 level physics courses. In addition, all students must satisfy the general Postgraduate School minimum requirements for the master's degree and present an acceptable thesis.

The following specific course requirements must be successfully completed for a student to earn the degree Master of Science in Physics:

1) PH3152: Mechanics II - Extended Systems,
   PH3352: Electromagnetic Waves,

PH3683: Intermediate Quantum Physics,
PH3990: Methods of Theoretical Physics,
PH3782: Thermodynamics and Statistical Physics, or equivalents to the above courses.

2) Either PH4353: Topics in Advanced Electricity and Magnetism
or PH4984: Advanced Quantum Physics.

3) In addition to the above, a graduate sequence containing at least two Physics courses, at least one of which must be at the 4000 level.

All programs leading to the degree Master of Science in Physics must be approved by the Chairman of the Department of Physics.

MASTER OF SCIENCE IN ENGINEERING SCIENCE

Students of the Weapon Systems Engineering Curriculum (530) who elect a Physics area as their specialization option will receive the degree Master of Science in Engineering Science. The program must include at least 36 credit hours of graduate work in engineering, science and mathematics, at least 12 of which must be at the 4000 level. Of these 36 hours, at least 20 hours, including work at the 4000 level, must be in the Department of Physics. This will be the major department and cognizance over the specialization course sequences, thesis research areas and the degree resides with the Chairman of the Department of Physics.

In addition to the major, the program must contain at least 12 hours at the graduate level in courses representing areas other than the major.

The candidate must present an acceptable thesis on a topic given prior approval by the Department of Physics. Final approval of the program leading to the Master of Science in Engineering Science with major in Physics shall be obtained from the Chairman of the Department of Physics.

MASTER OF SCIENCE IN APPLIED PHYSICS

To be awarded the degree Master of Science in Applied Physics, a student must complete program of study which includes at least 32 quarter hours of courses (not including thesis) at the graduate (3000 or 4000) level. Of these 32 hours, at least 15 hours must be at the 4000 level. Subject to the approval of the Chairman of the Department of Physics, a maximum of 40% of the hourly requirements in each of these categories may be taken outside the Physics Department in technical subjects related to Physics. The remaining 60% in each category must consist of Physics courses.

As part of the above requirements, a student's program must include an area of graduate concentration, containing at least four graduate courses approved by the Chairman of the Department of Physics. At least two of these courses must be at the 4000 level.

All programs leading to the degree Master of Science in Applied Physics must satisfy the general Postgraduate School minimum requirements for the Master's degree, must include an acceptable thesis, and must be approved by the Chairman of the Department of Physics.

DOCTOR OF PHILOSOPHY

The Ph.D. degree is offered in the department in several areas of specialization which currently include acoustics, atomic physics, space physics, theoretical physics, nuclear physics and plasma physics.

Requirements for the degree may be grouped into three categories: courses, thesis research and examinations in major and minor fields.

The required examinations are outlined under the general school requirements for the doctor's degree. In addition to the school requirements, the department requires a

preliminary examination to show evidence of acceptability as a doctoral student. The usual courses to be taken by the candidate include Classical Electrodynamics, Quantum Mechanics and Statistical Physics (PH4353, PH4971, PH4972, PH4973, PH4771). Suitable electives are to be chosen in physics and the minor fields. A minimum of 40 credit hours of physics courses at the 4000-level is required.

PHYSICS LABORATORIES

The physics laboratories are equipped to carry on instruction and research work in atomic physics, nuclear physics, electro-optics, plasma physics, spectroscopy and acoustics.

The 100 MeV electron linear accelerator provides a pulsed electron beam of 1 microampere average current and is used for radiation studies. This machine is augmented by a Pulserad 112 single pulse electron accelerator producing a 1.8 MeV, 40 kiloampere beam of 50 nanosecond duration. Both machines are suitable for studies of radiation effects in semiconductor devices and electromagnetic pulse generation.

The Electro-Optics Laboratory uses imaging and detecting systems from the far infrared to the visible range including instrumentation for seagoing experiments in optical propagation. The Laser Laboratory contains a giant pulse laser and associated detection equipment for the visible spectrum as well as a high power laser in the IR region.

The Acoustics Laboratory equipment includes a large anechoic chamber, a small reverberation chamber and a multiple-unit acoustics laboratory for student experimentation in airborne acoustics. Sonar equipment, test and wave tanks and instrumentation for investigation in underwater sound comprise the underwater acoustics laboratory. The physical acoustics laboratories are equipped with a variety of modern data collection and processing equipment.

COURSE OFFERINGS

PH0110 REFRESHER PHYSICS (NO CREDIT) (Meets last 6 weeks of quarter) (5-3).
A six-week course of selected topics from elementary physics for incoming students. Typical subjects are kinematics, Newton's laws of motion, work, energy, linear and angular momentum. Vector algebra and some aspects of calculus are developed as needed and their use is emphasized. The two, 90-minute laboratory periods are guided problem solving. PREREQUISITES: Previous college courses in elementary physics and integral calculus.

PH0499 ACOUSTICS COLLOQUIUM (NO CREDIT) (0-1).
Reports on current research and study of recent research literature in conjunction with the student thesis. PREREQUISITE: A course in acoustics.

PH0810 THESIS RESEARCH (0-0).
Every student conducting thesis research will enroll in this course.

PH0999 PHYSICS COLLOQUIUM (NO CREDIT) (0-1).
Discussion of topics of current interest by NPS and outside guest speakers.

PH1121 PHYSICS I: MECHANICS (4-2).
Vector algebra, particle kinematics in one and two dimensions, Newton's laws of motion, particle dynamics, work and energy, conservation of energy, systems of particles, conservation of momentum, rotational kinematics and dynamics, gravitation, simple harmonic motion. PREREQUISITE: A course in calculus (may be taken concurrently).

PH1322 PHYSICS II: ELECTRICITY AND MAGNETISM (4-1).
Electric charge, Coulomb's Law, electric field, Gauss' Law, electrical potential and energy, capacitors and dielectrics, current and resistance, EMF and DC circuits, magnetic field, Ampere's Law, Faraday's Law, inductance, electromagnetic oscillations, AC circuits, Maxwell's Equations, electromagnetic waves. PREREQUISITE: PH1121 or equivalent.

PH1331 BASIC PHYSICS (4-0).
This course covers the fundamentals of mechanics, electromagnetic fields and waves. Designed to support the Intelligence and Space Systems Operations Curricula, it should nevertheless serve any student who has successfully taken a course in physics, (even in the dim past). PREREQUISITE: Elementary calculus (may be taken concurrently).

PH2001 PHYSICS THESIS OPPORTUNITIES (1-0).
This course is designed for students interested in choosing and pursuing a Master's thesis in physics. Members of the faculty of the Department of Physics having research projects suitable for Master's degree theses will give presentations on their projects. The course is given in the pass/fail mode. PREREQUISITES: At least 7 quarter hours of physics courses.

PH2012 PHYSICS LABORATORY I (1-3).
Introduction to the physics laboratory environment. Applications of probability, statistics and error analysis in physical measurements. Laboratory experiments in mechanics and optics, such as: elastic properties of solids; simple harmonic motion; standing waves; simple lenses; the velocity of light; laws of reflection and refraction; dispersion; optical fibers; polarization; optical interference; diffraction. PREREQUISITES: Previous college courses in basic physics and calculus, and PH2223 (may be concurrent).

PH2013 PHYSICS LABORATORY II (1-3).
Laboratory experiments dealing with electronic measurements and signal analysis. Basic electronic circuits, amplifiers and filters. Common electronic instruments and their uses. Applications of computers in signal processing. Practical Fourier analysis with the fast Fourier transform. Sampling theory, convolution, correlation, numerical filtering. Noise statistics and noise treatment through filtering, coherent averaging, phase-sensitive detection. PREREQUISITES: PH2012 and PH2351 (may be concurrent).

PH2014 PHYSICS LABORATORY III (1-3).
The modern quantum physics laboratory. Counting statistics and their use in the analysis of discrete events. Typical experiments: spectroscopic investigation of atomic energy levels and transitions, photo-electric effect, Planck blackbody radiation, electron charge-to-mass ratio, diffraction of x-rays and electrons, Franck-Hertz experiment, numerical simulations of quantum mechanical behavior. PREREQUISITES: PH2013 AND PH2681 (may be concurrent).

PH2119 OSCILLATION AND WAVES (4-2).
An introductory course designed to present mechanics to students studying acoustics. Kinematics, dynamics and work and energy consideration for the free, damped and driven oscillators. The wave equation for transverse vibration of a string, ideal and realistic boundary conditions and normal modes. Longitudinal and transverse waves in bars. Transverse waves on rectangular and circular membranes. Vibrations of plates. Laboratory periods include problem sessions and experiments on introduction to experimental techniques and handling of data; the simple harmonic oscillator analog; transverse waves on a string; and transverse, longitudinal and torsional waves on a bar. PREREQUISITES: Courses in differential equations and basic physics.

PH2151 MECHANICS I - PARTICLE MECHANICS (4-1).
After a review of the fundamental concepts of kinematics and dynamics, this course concentrates on those two areas of dynamics of simple bodies which are most relevant to applications in Weapon Systems Engineering: vibrations and projectile motion. Topics include: damped and driven oscillations, projectile motion with atmospheric friction, satellite orbits and rotating coordinate systems. PREREQUISITES: PH1121 or equivalent; MA2121 or equivalent course in ordinary differential equations (may be concurrent).

PH2203 TOPICS IN BASIC PHYSICS: WAVES AND OPTICS(4-0).
A course to provide physical background to wave motion, acoustics, and optics for students in the Electronic Warfare Curriculum and to provide applications of analytical techniques to physical problems. Areas covered are harmonic motion-differential equations, complex

notation, damped vibration and resonance; wave motion (properties of waves, sound waves, optics), geometrical and wave optics. PREREQUISITES: MA2138, MA2047; may be taken concurrently.

PH2207 FUNDAMENTALS OF ELECTRO-OPTICS (4-0).
This course is designed to provide students in interdisciplinary curricula with specific prerequisite background for electro-optics courses in those curricula. Topics discussed include: matrix formulation of optics, catoptric and catadioptric systems, diffraction, behavior of gaussian profile beams, Fourier optics and resolution, atmospheric transmission, atomic and molecular energy states, line shapes, band theory of semiconductors, the p-n junction, light emitting diodes, stimulated emission and lasers. PREREQUISITES: MA3139 and PH2304 (or equivalent).

PH2223 PHYSICS III: OPTICS (4-1).
Geometrical Optics: laws of reflection and refraction; dispersion; image-forming systems using lenses and mirrors; aberrations; optical fibers; matrix methods. Physical optics: electromagnetic wave equation; principle of superposition; polarization; Fresnel relations; phase and group velocities; interference and interferometry; diffraction; Fourier optics; holography. PREREQUISITES: Previous college courses in basic physics and calculus.

PH2304 TOPICS IN BASIC PHYSICS: ELECTROMAGNETISM (2-0).
This course follows PH2203 in the Electronic Warfare Systems curriculum. Basic concepts of electric and magnetic fields are introduced and their interaction with charges and currents discussed. The experimental laws are used to develop Maxwell's Equations and simple solutions to these equations are considered. The course is normally taught in a six-week period. PREREQUISITES: PH2203 or equivalent and mathematics through vector analysis and ordinary differential equations.

PH2351 ELECTROMAGNETISM (4-1).
Electrostatic fields in vacuum and dielectrics, Poisson's and Laplace's equations, electrostatic energy, electric current. The magnetic field of steady currents, Biot-Savart and Ampere's Laws, vector potential, magnetic properties of matter. Electromagnetic induction and Faraday's Law. Magnetic energy. Maxwell's Equations. PREREQUISITES: PH1322 or equivalent, MA2047 or equivalent.

PH2401 INTRODUCTION TO THE SONAR EQUATIONS (3-0).
A discussion of each term of the sonar equations, with application to the detection, localization and classification of underwater vehicles. Topics include ray acoustics, simple transmission loss models, tonals, spectrum and band levels, directivity index, array gain, doppler shift and detection threshold. This course is intended primarily for students in the Antisubmarine Warfare Curriculum and is given in a "structured" PSI mode. PREREQUISITE: Precalculus mathematics.

PH2410 ANALOG ELECTRONICS AND SIGNAL CONDITIONING FOR ACOUSTICS (3-2).
Applications of simple integrated circuits to acoustical measurements including op-amp filters and amplifiers, voltage controlled oscillators, D-to-A, A-to-D and frequency-to-voltage converters. Sources of noise (thermal and quantization) in electro-acoustic systems. Techniques of noise reduction in the frequency and time domains including signal integration and time averaging, digital and analog Fourier analysis, phase sensitive detection and time domain auto- and cross-correlation analysis. PREREQUISITES: PH2012 and EC2170.

PH2511 INTRODUCTION TO ORBITAL MECHANICS (4-0).
The gravitational two-body problem. Elliptic orbits and orbital elements. Orbital maneuvers and transfers. Time of flight. Ground track. Additional topics selected from the following: suborbital trajectories, hyperbolic trajectories, orbit determination from radar data, sun synchronous orbits, Molniya orbits and orbital perturbations. PREREQUISITES: A course in basic mechanics (including vectors) and a course in ordinary differential equations.

PH2514 INTRODUCTION TO THE SPACE ENVIRONMENT (4-0).
Plasma concepts. Solar structure and magnetic field, particle and electromagnetic emissions from the sun, the geomagnetic field and the magnetosphere; radiation belts, structure and properties of the earth's upper atmosphere, ionosphere. Implications of environmental factors for spacecraft design. PREREQUISITE: A course in basic electricity and magnetism.

PH2601 SURVEY OF MODERN PHYSICS (4-1).
This is a one-term course covering the fundamentals of modern physics with selected applications. Topics include special relativity, the wave-particle duality, the Schrodinger equation, atoms and molecules, lasers, semiconductors and superconductors. PREREQUISITE: PH2223.

PH2681 INTRODUCTORY QUANTUM PHYSICS (4-0).
Special relativity plus the fundamental concepts of quantization in modern physics. Topics include the Bohr atom, blackbody radiation, wave-particle duality, the Schrodinger equation and its application to potential barriers and wells and to the harmonic oscillator and the hydrogen atom. Also the Pauli exclusion principle, spin and angular momentum. PREREQUISITES: PH2151 and PH2223. A Course in theoretical physics (PH3990) desirable but not mandatory.

PH2724 PHYSICS IV: THERMODYNAMICS (4-0).
Equations of state; the concepts of temperature, heat and work; the first law of thermodynamics; heat engines and refrigerators; entropy and the second law of thermodynamics; thermodynamic potentials; phase equilibrium; kinetic theory; equipartition theorem; transport phenomena. PREREQUISITES: PH1121 and a course in multivariable calculus.

PH2911 INTRODUCTION TO COMPUTATIONAL PHYSICS (3-2).
An introduction to the role of computation in modern physics with emphasis on the programming of current nonlinear physics problems and the use of graphics. Includes an introduction to BASIC, FORTRAN and C as well as the DOS and UNIX operating systems. Exercises emphasize physical problems and overlap with concurrent courses in differential equations and vector analysis. Subject matter includes projectile trajectories with air drag, nonlinear celestial mechanics, damped and driven nonlinear oscillators, and numerical integration methods. PREREQUISITE: A basic physics course.

PH3002 NON-ACOUSTIC SENSOR SYSTEMS (4-0).
This course covers the physical principles underlying the operation of a number of operational and proposed non-acoustic sensor systems. Geomagnetism, magnetometers and gradiometers, MAD signatures, optical and IR transmission in the atmosphere and in sea water. Image Converter, FLIR and radar systems for ASW. Exotic detection schemes. PREREQUISITES: PH3360, EO3720 and SECRET clearance.

PH3006 WEAPONS SYSTEMS AND WEAPONS EFFECTS (4-0).
This course will cover technical aspects of three areas of modern weapons systems: Nuclear weapons and effects on personnel, equipment and structures; principles of directed energy weapon concepts and their interactions with targets; space based defense system concepts. PREREQUISITE: SE3301 or equivalent.

PH3152 MECHANICS II - EXTENDED SYSTEMS (4-1).
The principles of dynamics are applied to real extended bodies. Topics include: principles of rocket propulsion, rotational motion of axisymmetric bodies and its application to projectile spin and gyroscopic motion. An introduction to generalized methods of description of dynamic systems is given and the general behavior of complex vibrating systems is studied. PREREQUISITE: PH2151.

PH3161 FLUID DYNAMICS (4-1).
This course emphasizes the dynamics of real compressible fluids. The basic properties of fluids are introduced and the concepts of fluid kinematics, stress and strain are discussed. Both the control volume and differential equation approaches are applied to the flow of

viscous fluid. The laws of similarity are developed and the significance of Reynolds, Fraude and Mach number discussed. Topics covered include laminar and turbulent flow, isentropic subsonic channel flow, supersonic flow in nozzles and two-dimensional supersonic flow. PREREQUISITE: PH2151 or equivalent.

PH3166 PHYSICS OF UNDERWATER VEHICLES (4-2).
This course emphasizes the dynamics of real incompressible liquids. The basic properties of fluids are introduced and the concepts of fluid kinematics, stress and strain are discussed. Both the control volume and the differential equation approaches are applied to the flow of a viscous fluid. The laws of similarity are developed and the significance of Reynolds, Fraude and Mach numbers are discussed. Topics covered include laminar flow, turbulent flow, boundary layer theory and the calculation of lift and drag. One or more special topics may be discussed (surface waves, cavitation and the fluid-dynamic generation of sound) depending upon the interests of the instructor and students. PREREQUISITE: PH2151 or equivalent.

PH3208 ELECTRO-OPTIC PRINCIPLES AND DEVICES (4-1).
This course is designed to provide students in inter-disciplinary programs with a general understanding of the principles and capabilities of the component devices comprising military electro-optic and infrared systems. Topics treated include: atmospheric extinction, turbulence, thermal blooming and breakdown, adaptive optics, thermal radiation, target signatures, backgrounds, electro-optic and acousto-optic devices, reticles and other trackers, detector characteristics, noise and cooling, television, CCD, CID and scanning imagers. Laboratory work provides hands-on familiarity with these devices. PREREQUISITES: PH2203, PH2207, MA3139 or equivalent.

PH3252 ELECTRO-OPTICS (4-0).
This course treats the properties of electro-optic systems together with the basic physical principles involved. Topics included are: diffraction and Fourier transform methods; optical data processing; Fresnel equations, evanescent waves, film and fiber optics; Gaussian beams and laser resonators; molecular spectra, transition probability, line widths and laser gain; specific lasers, Q-switching and mode locking; semi-conductors, junction diodes, photodetection, light emitting diodes and diode lasers. PREREQUISITES: PH3352, PH3683.

PH3352 ELECTROMAGNETIC WAVES (4-0).
Maxwell's equations. Energy density and Poynting vector, boundary conditions. Polarization. Propagation of uniform plane waves in vacuum, dielectrics, conducting media (with emphasis on sea water) and low-density neutral plasmas. Reflection and refraction at plane dielectric and conducting boundaries, at normal and oblique incidence. Rectangular wave guides. PREREQUISITE: PH2351.

PH3360 ELECTROMAGNETIC WAVE PROPAGATION (4-1).
Introduction to vector fields and the physical basis of Maxwell's equations. Wave propagation in a vacuum, in dielectrics and conductors and in the ionosphere. Reflection and refraction at the interface between media. Guided waves. Radiation from a dipole. PREREQUISITES: MA2121 and a course in basic electricity and magnetism.

PH3402 UNDERWATER ACOUSTICS (4-1).
The third of a four-course sequence in acoustics for students in the ASW curriculum, this course is an analytical study of those aspects of underwater sound that influence the sonar equations. Topics include: The wave equation in fluids; acoustic properties of fluids; plane, spherical and cylindrical waves; absorption of sound in sea water; simple sources; transducer properties and sensitivities; surface interference; three-element array; normal and oblique incidence reflection and transmission at boundaries; image theory and the shallow-water channel; continuous line source and the plane circular piston; radiation impedance; linear arrays with steering; the Eikonal Equation and ray theory. Laboratory experiments include advanced acoustic instrumentation, longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers and the 3-element array. PREREQUISITES: PH2119 or equivalent and PH2401.

PH3410 FIBER-OPTIC SYSTEMS FOR ACOUSTICS (3-2). Introduction to the physics of electro-optical sources (lasers and LED's) and photodetectors and the principles of light propagation in optical fibers. Fiber-optic communication system considerations including component specification, data rates and power budget. Introduction to fiber-optic sensor systems. PREREQUISITES: PH2410, PH3360 and EC2500.

PH3451 FUNDAMENTAL ACOUSTICS (4-2).
Development of and solutions to the acoustic wave equation in fluids. Propagation of plane, spherical and cylindrical waves in fluids. Sound pressure level, intensity and specific acoustic impedance. Normal and oblique incidence reflection and transmission from plane boundaries. Transmission through a layer. Image theory and surface interference. Sound absorption and dispersion for classical and relaxing fluids. Acoustic behavior of sources and arrays, acoustical reciprocity, continuous line source, plane circular piston, radiation impedance and the steered line array. Transducer properties, sensitivities and calibration. Laboratory experiments include longitudinal waves in an air-filled tube, surface interference, properties of underwater transducers, three-element array, speed of sound in water and absorption in gases. PREREQUISITES: PH2119 and PH2724.

PH3452 UNDERWATER ACOUSTICS (4-2).
This course is a continuation of PH3451. Lumped acoustic elements and the resonant bubble. Introduction to simple transducers. Normal modes in rectangular and cylindrical enclosures. Steady-state response of acoustic waveguides of constant cross section, propagating evanescent modes and group and phase speeds. Transmission of sound in the ocean, the Eikonal Equation and necessary space conditions for ray theory and refraction and ray diagrams. Sound propagation in the mixed layer, the convergence zone and the deep sound channel. Passive sonar equation, ambient noise and doppler effect and bandwidth considerations. Active sonar equations, target strength and reverberation. Laboratory experiments include Helmholtz resonators, normal modes in rectangular, cylindrical and spherical enclosures, water-filled waveguide, noise analysis, impedance of a loudspeaker. PREREQUISITE: PH3451

PH3458 NOISE, SHOCK AND VIBRATION CONTROL (4-0).
The application of the principles of acoustics and mechanics to the problems of controlling noise, vibration and mechanical shock. Topics include linear mechanical vibrations; introduction to vibrations of nonlinear systems; damping mechanisms; vibration and shock isolation; noise generation and control; effects of noise on man; application to problems of Naval interest such as ship quieting and industrial noise control. PREREQUISITE: A course in acoustics.

PH3479 PHYSICS OF UNDERWATER WEAPONS (4-0).
The basic physics of underwater weapons from launch through explosion are addressed using a modern acoustic torpedo to illustrate practical applications. Topics include initial inputs, water entry, power plants, propulsors, drag and drag reduction, stability and control, guidance, acoustic search, terminal homing, exploders and explosions. An historical summary of U.S. torpedoes and depth charges and a review of current NATO and Soviet torpedoes is also presented. PREREQUISITES: A course in acoustics and a SECRET NOFORN clearance.

PH3513 INTERMEDIATE ORBITAL MECHANICS (Variable hours 2-0 to 4-0).
Orbital perturbations due to various sources, such as atmospheric drag and lunar tidal effects. Interplanetary trajectories. Additional topics depending on hours assigned to course. PREREQUISITE: PH2511.

PH3516 ENVIRONMENTAL FACTORS IN SPACECRAFT DESIGN AND OPERATIONS (3-0).
The environmental effects covered in this course include spacecraft charging, space radiation effects, natural and artificial space debris, and atmospheric effects. The nature of the physical interactions is emphasized. PREREQUISITE: PH2514.

PH3683 INTERMEDIATE QUANTUM PHYSICS (4-1).
Applies the fundamental concepts of quantum physics to the development and application of theoretical methods for dealing with real systems. Topics covered: Orthogonal expansions; time independent and time dependent perturbation theory. Helium and multi-electron atoms and spectra. The periodic table; diatomic molecules; lasers; solids and semiconductors. PREREQUISITES: PH2681 and PH3990.

PH3782 THERMODYNAMICS AND STATISTICAL PHYSICS (4-0).
Entropy, temperature, Boltzmann factor and Gibbs factor are developed from a quantum point of view. Blackbody radiation, chemical potential, partition function, Gibbs sum and applications to an ideal gas are covered. Fermi-Dirac and Bose-Einstein statistics and applications to degenerate systems. Gibbs free energy, Helmholtz free energy, enthalpy, kinetic theory, phase transformations, chemical reactions. PREREQUISITE: PH2681.

PH3855 NUCLEAR PHYSICS (4-2).
This is the first in a sequence of graduate specialization courses on nuclear weapons and their effects. This course deals with the necessary underlying principles of nuclear physics, including nuclear forces, models, stability, reactions and decay processes and interaction of high energy particles with matter. The laboratory includes radiation detection techniques and statistics of counting. PREREQUISITES: PH3152, PH3360 and PH3683 or equivalents.

PH3921 NONLINEAR DYNAMICS, CHAOS, FRACTALS AND ALL THAT (Variable hours 2-0 to 3-0).
The existence of chaotic dynamics has been discussed in the literature for many decades and is associated with names like Poincare, Birkhoff, Kolmogorov and others. However, it is only recently that the wide ranging impact of chaos has been recognized. The field is undergoing explosive growth and many applications have been made across a broad spectrum of scientific disciplines - ecology, economics, physics, chemistry, engineering and fluid mechanics. Much effort is driven by the hope that it may be possible to find unifying principles that characterize and classify large classes of nonlinear complex systems. This course is an introduction into the concepts and the language used in this rapidly growing exciting field from a physicist's point of view. PREREQUISITE: PH2151 or equivalent.

PH3990 METHODS OF THEORETICAL PHYSICS (4-0).
A selection of mathematical techniques applied to specific problems drawn from physical systems, such as classical waves, scattering, electrodynamics, resonant cavities, incompressible flow, dielectric and magnetic media, heat conduction, Fourier optics and quantum mechanics. Topics may include complex variables, series solutions of differential equations, Fourier analysis and Green's functions. PREREQUISITES: MA2089, MA2121 and a sequence of courses in basic physics.

PH3998 SPECIAL TOPICS IN INTERMEDIATE PHYSICS (Variable hours 1-0 to 4-0).
Study in one of the fields of intermediate physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading in different topics. PREREQUISITES: A 2000-level course appropriate to the subject to be studied and consent of the Department Chairman. The course may also be taken on a Pass/Fail basis provided the student has requested so at the time of enrollment.

PH4054 PARTICLE BEAM AND HIGH ENERGY LASER WEAPON PHYSICS (4-0).
This course is an in-depth study into the beam weapon concepts. Topics covered are: relativistic electron beams; their equilibrium, propagation losses and stability; giant power accelerator concepts; target interaction; proton beams; neutral particle beams, their production and limitations; high power microwave beams, high energy laser beams, their production, atmospheric propagation and control and their interaction with targets. PREREQUISITES: PH3352, PH2151 or equivalent courses in electromagnetism and mechanics. SECRET clearance.

PH4162 MECHANICS OF CONTINUA (3-0).
The foundations of fluid mechanics presented in the tensor formulation. Scalars, vectors and tensors. Tensor differential and integral calculus. The stress tensor and rate of deformation tensor. Principal values, deviators and other invariants. Fundamental laws: conservation of mass, linear momentum, angular momentum and energy. Constitutive equations. Non-Newtonian fluids. Visco-Plastic materials. PREREQUISITE: PH3161 or equivalent.

PH4209 EO/IR SYSTEMS AND COUNTERMEASURES (3-2).
This unclassified course for students in interdisciplinary curricula treats the military applications of electro-optic systems, including IR and EO seekers and trackers, surveillance and missile warning systems and laser rangers and designators. Scanning FLIR and IRST systems and array applications will be included. Signature suppression and generic active and passive countermeasure approaches will be discussed. Laboratory work will deal with EO/IR devices and possible countermeasure techniques. PREREQUISITES: PH3208 and MA3139.

PH4253 SENSORS, SIGNALS AND SYSTEMS (4-2)
This course treats the physical phenomena and practical problems involved in sensor systems for electromagnetic signals in the EO/IR range. Topics included are: optical modulation, nonlinear optics, acousto-optics; atmospheric molecular absorption characteristics and mechanisms of detectors for optical and infrared radiation, noise in detectors, cooling systems; image intensifiers, television and FLIR systems; detecting, tracking and homing systems; signal sources, target signatures and backgrounds laser target designators, laser radars, the range equation. The laboratory will include experiments related to this material as well as to that of the preceding course, PH3252. PREREQUISITES: PH3252 and a course in electromagnetism.

PH4254 THERMAL IMAGING AND SURVEILLANCE SYSTEMS (4-0).
This course is intended as a capstone course to follow the sequence PH3252 and PH4253, or the sequence PH2207 and PH3208. It will address the system analysis and technology of infrared imaging and search/track systems, including the derivation of system performance measures such a Minimum Detectable Temperature Difference, (MDT) and Minimum Resolvable Temperature Difference (MRTD) in terms of the optics, scanner, detectors, display and human operator characteristics. Performance Predication codes and Tactical Decision Aids (TDAs) will be analyzed for current Forward Looking Infra Red (FLIR) Systems and comparable codes for IRSTs discussed. Criteria for target detection and transference of contrast will be compared. Integrated Focal Plane Array Technology will be explored for application to second generation FLIR and Staring Imager development. PREREQUISITE: PH3208 or PH4253 or consent of instructor.

PH4283 LASER PHYSICS (4-0).
The physics of lasers and laser radiation. Topics will include: spontaneous and stimulated emission, absorption, interaction of radiation with matter, line broadening mechanisms, optical and electrical pumping, gain, properties of laser beams. Gaussian beams, stable and unstable resonators, rate equations, output coupling, mode locking, short pulsing, specifics of solid state and gas laser systems, high energy and high power lasers, laser-surface interaction, air breakdown, laser supported detonation waves, laser isotope separation and laser fusion. PREREQUISITE: PH3252 or equivalent, or consent of instructor.

PH4353 TOPICS IN ADVANCED ELECTRICITY AND MAGNETISM (4-0).
Topics selected from electromagnetic radiation, including radiation from antennas and accelerating particles and radiation scattering from charged particles. Additional topics may include Cerenkov radiation, free electron lasers and the relativistic formulation of electrodynamics. PREREQUISITES: PH3152, PH3352 and PH3990.

PH4371 CLASSICAL ELECTRODYNAMICS (3-0).
Tensors in special relativity. Classical relativistic electromagnetic field theory. Lorentz electron theory. PREREQUISITES: PH4353 and familiarity with the special theory of relativity and Lagrangian mechanics.

PH4403 ADVANCED TOPICS IN UNDERWATER ACOUSTICS (4-1).
The last in a sequence of courses in acoustics for students in the ASW curriculum, this course is a continuation of PH3402. Topics include: review of the sonar equations, normal modes in enclosures, steady-state response of isospeed acoustic waveguides, propagating and evanescent modes, group and phase speeds, the wave equation with a source term, the point source in cylindrical coordinates, transmission loss models for isospeed shallow water channel with fluid bottom, the parabolic equation and the parametric array. Laboratory experiments include analysis of underwater noise, normal modes in a rectangular cavity and acoustic waveguides. PREREQUISITE: PH3402 or equivalent.

PH4410 ADVANCED ACOUSTICS LABORATORY (1-6).
Advanced laboratory projects in acoustics. Through the performance of experiments drawn from diverse fields of acoustics, the student is introduced to the problems and opportunities of acoustics research. For each experiment the student is guided through the scientific literature on the subject, the construction of the equipment, the collection and analysis of the data and the writing of a research report. PREREQUISITE: PH3452.

PH4453 SCATTERING AND FLUCTUATION OF SOUND IN THE OCEAN (4-0).
An advanced treatment of the effects of variations of the ocean and its boundaries on ocean noise and the scattering and fluctuation of sound. Topics include: multipole radiation fields and noise sources in the sea, coherence and incoherence, probability density functions, the Hemholtz integral and general scattering formalism, scattering from objects, correlations and frequency spectra of sound scattered from rough boundaries, fluctuations associated with variability in the medium. PREREQUISITE: PH3452 or consent of the instructor.

PH4454 TRANSDUCER THEORY AND DESIGN (4-2).
A treatment of the fundamental phenomena basic to the design of transducers for underwater sound, specific examples of their application and design exercises. Topics include piezoelectric, magnetostrictive and hydromechanical effects. Laboratory includes experiments on measurement techniques, properties of transducer materials, characteristics of typical transducer types and a design project. PREREQUISITE: PH3452 (may be taken concurrently).

PH4455 SOUND PROPAGATION IN THE OCEAN (4-0).
An advanced treatment of the subject. Topics include; reflection of spherical waves from ocean boundaries; normal mode propagation of sound; inhomogeneous wave equation and the point source in cylindrical coordinates; shallow water channel with fluid and solid bottoms; the deep sound channel and the WKB approximation; range-dependent channels; adiabatic normal modes and the parabolic equation; multi-path propagation. Application to Arctic Ocean acoustics. PREREQUISITE: PH4453 or consent of instructor.

PH4456 SEMINAR IN APPLICATION OF UNDERWATER SOUND (3-0).
A study of current literature on application of acoustics to problems of Naval interest. PREREQUISITE: PH3402 or PH3452 or PH4403 or consent of the instructor.

PH4459 SHOCK WAVES AND HIGH-INTENSITY SOUND (3-0).
Nonlinear oscillations and waves on strings. The nonlinear acoustic wave equation and its solution. The parametric array. The physics of shock waves in air and in water. PREREQUISITE: PH3451.

PH4515 PHYSICS OF THE SATELLITE ENVIRONMENT (3-0).
A graduate-level treatment of the structure and properties of the near earth space environment and some aspects of solar physics. Topics (usually two per quarter) are chosen from: ionospheric composition, ionospheric radio wave propagation, structure of the magnetosphere, the geomagnetic field, solar structure and emissions. PREREQUISITES: PH2514 and a 3000 level course in electromagnetism. Some background in plasma physics is desirable.

PH4531 INTRODUCTION TO ASTROPHYSICS (4-0).
Introduction to theories of stellar structure, energy transport in stars and stellar evolution. Recent advances in solar physics. Supernovae, pulsars, black holes and the origin of the universe will be topics of discussion. PREREQUISITES: PH3152 and PH3352.

PH4661 PLASMA PHYSICS I (4-0).
This course constitutes a broad study of the behavior and properties of gaseous plasma, the fourth -- and most abundant -- state of matter in the universe. Plasma physics is a vigorously developing branch of contemporary physics. Its many applications are in areas such as astro and space-physics, atomic physics, magneto-hydrodynamic power generation, electron beam excited laser, laser isotope enrichment, ionospheric communication, thermonuclear fusion and high energy beam weapons. The physical concepts fundamental to various branches of plasma physics are introduced. Topics covered include single particle motions in electromagnetic fields, orbit theory, collision phenomena, breakdown in gases and diffusion. The magneto-hydrodynamic and the two-fluid plasma models are considered. PREREQUISITE: PH3360 or the equivalent.

PH4662 PLASMA PHYSICS II (3-0).
A continuation of Plasma Physics I. Applications of the hydromagnetic equations to the study of macroscopic motions of plasma. Equilibrium and stability. Classification of plasma instabilities. Kinetic theory, the Boltzmann equation and the macroscopic-momentum transport equation. Plasma oscillations and Landau damping. Nonlinear effects, shock waves, radiations from plasma, including bremsstrahlung and cyclotron radiation. Controlled fusion and laser-produced plasmas. PREREQUISITE: PH4661 or consent of instructor.

PH4663 ADVANCED PLASMA PHYSICS (3-0).
Selected topics in plasma physics, such as laser-target interaction, dynamics of a laser-produced plasma, self-generated magnetic fields, plasma surface interactions, unipolar arcing, plasma opening switch. PREREQUISITE: PH4662 or consent of instructor.

PH4750 SOLIDS AND RADIATION EFFECTS (4-0).
An introduction to solid state physics and radiation effects. Free electron theory, bands, semiconductors and lattice structure are discussed. Radiation damage mechanisms, TREE and hardening concepts are introduced. PREREQUISITES: PH3352 and PH3683.

PH4760 SOLID STATE PHYSICS (4-0).
Fundamental theory dealing with solids: crystals, binding energy, lattice vibration, dislocations and mechanical properties, free electron theory, band theory, properties of semi-conductors and insulators, and magnetism. PREREQUISITES: PH3683 and PH3782 (the latter may be taken concurrently).

PH4771 STATISTICAL PHYSICS I (3-0).
Kinetic theory and the Boltzmann theorem, configuration and phase space, the Liouville theorem, ensemble theory, microcanonical, canonical and grand canonical ensembles, quantum statistics. Applications to molecules, Bose-Einstein gases, Fermi-Dirac liquids and irreversible processes. PREREQUISITES: PH3152, PH3683 and PH3782.

PH4856 PHYSICS OF NUCLEAR EXPLOSIONS (4-0).
This second course in the nuclear weapons effects graduate specialization sequence considers in-depth questions of weapon designs and their specific output environments which are created by the nuclear explosion. Topics are: principles affecting weapon yield efficiency; explosion phenomenology in various ambient environments, blast and shock, thermal radiation, X-rays and gamma rays, neutron fluxes, electromagnetic pulse, radioactive fallout models. PREREQUISITES: PH3855 and SECRET clearance.

PH4857 RADIATION HYDRODYNAMIC TRANSPORT THEORY (4-0).
This course collects in systematic fashion most of the physical ingredients of the large Radiation-Hydrodynamic Computer Codes for nuclear weapon development, nuclear explosion phenomena, particle beam transport and beam-target interaction. Topics are: Boltzmann transport equation, general theory of transport processes in multi-component

gases with reactions and ionization; radiation transport theory; opacity models; shock front structure. PREREQUISITES: PH4856 and SECRET clearance.

PH4881 ADVANCED NUCLEAR PHYSICS (3-0).
Topics according to the interests of students and instructor. PREREQUISITE: PH3855 or equivalent.

PH4911 SIMULATION OF PHYSICAL AND WEAPON SYSTEMS (3-2).
Comparisons between simulation, theory and experimentation as techniques of scientific investigation. Applications emphasize physical principles of weapons development. Subject matter includes nonlinear oscillations, numerical integration methods, molecular dynamics in solids, liquids and gases, numerical chaos, wave propagation in various media, distributions of random numbers, calculation of static electromagnetic fields, and Monte Carlo simulation techniques. The combat simulation BATMAN AND ROBIN, a carrier group battle simulation that is presently used in the Operation Research WARLAB, will be examined in this course. PREREQUISITE: A graduate physics course.

PH4971 QUANTUM MECHANICS I (3-0).
Review of Lagrange's and Hamilton's equations of motion. Poisson brackets. General principles of non-relativistic quantum mechanics; stationary states. PREREQUISITES: PH2681 and PH3152.

PH4972 QUANTUM MECHANICS II (3-0).
Addition of angular momenta; scattering theory; additional topics of interest to students and instructor. PREREQUISITE: PH4971.

PH4973 QUANTUM MECHANICS III (3-0).
General principles of relativistic quantum mechanics. Properties and solutions of relativistic wave equations. PREREQUISITES: PH4371 and PH4971.

PH4984 ADVANCED QUANTUM PHYSICS (4-0).
Quantum mechanics in the Dirac format. Angular momentum, spin, spin resonance. Additional topics may include group theoretical applications to selection rules and crystal fields, variational principles, self-consistent fields in the many-electron atom, scattering theory and polyatomic molecules. PREREQUISITES: PH3152 and PH3683.

PH4991 RELATIVITY AND COSMOLOGY (3-0).
Einstein's general theory of relativity. The three classical tests. The Schwarzchild singularity and black holes. Cosmological models and their relations with observations. Introduction to modern developments; gravitational waves, problems of quantum cosmology and superspace. PREREQUISITE: PH4371.

PH4998 SPECIAL TOPICS IN ADVANCED PHYSICS (Variable hours 1-0 to 4-0).
Study in one of the fields of advanced physics and related applied areas selected to meet special needs or interests of students. The course may be conducted as a seminar or supervised reading. The course carries a letter grade and may be repeated in different topics. PREREQUISITES: A 3000-level course appropriate to the subject to be studied and consent of the Department Chairman. It may also be taken on a Pass/Fail basis if the student has requested so at the time of enrollment.

SE3004 WEAPONS SYSTEM ANALYSIS (4-0).
This course is designed to support the Intelligence Curriculum. It treats the behavior of weapons systems as influenced by the physical properties of the environment and the physical properties of the devices incorporated into the systems. The course material includes: principles of electronic reconnaissance, antennas and their characteristics, factors affecting receiver sensitivity, transmission range, radar principles, the radar equation, optics fundamentals, infrared nomenclature, principles and elements of photographic science, electro-optical systems (with some background in semiconductors), sonar and non-acoustic ASW (Antisubmarine Warfare). PREREQUISITE: PH1331 or equivalent.

SE3301 RADIATING SYSTEMS (4-0).
This course for students of Operations Research and other Weapon System oriented non-engineering curricula discusses the physical principles exploited by information gathering systems with emphasis on general capabilities and limitations. After a general introduction to wave propagation, topics of discussion are electromagnetic waves, radar, electro-optics including lasers and underwater sound. These topics will be applied to specific systems such as missile guidance, sonobouys and phased arrays as appropriate to the class and instructor. PREREQUISITE: MA1116 or equivalent may be taken concurrently, or by consent of instructor.

SE4006 TECHNICAL ASSESSMENT OF WEAPON SYSTEMS (4-0).
This course is designed to support the Intelligence Curriculum. Current technical trends in weapon system technologies which are expected to significantly affect warfare are investigated. Topics covered are: nuclear weapons and their effects, nuclear strategic balance, satellite orbits, directed energy weapon concepts (SDI), future weapon concepts. PREREQUISITES: SE3004 or equivalent and SECRET clearance.

SE4858 NUCLEAR WARFARE ANALYSIS (4-0).
This final course in the nuclear weapons effects graduate specialization sequence deals with technical aspects of strategic and tactical nuclear war. Effects which nuclear weapons explosion environments have on various defense platforms and systems are considered together with methods of hardening to reduce system vulnerability in each of the effected areas: blast and shock, thermal radiation, transient effects on electronics. EMP, biological effects from contamination, atmospheric and ionospheric effects on communication, detection and surveillance systems. PREREQUISITES: PH3461, PH4856 and SECRET clearance.

SPACE SYSTEMS ACADEMIC GROUP

Chairman:
Rudolf Panholzer
Professor
Code SP, Bullard Hall
Room 205
(408) 656-2278
DSN 878-2278

The Space Systems Academic Group is an interdisciplinary association of faculty, representing eight separate academic disciplines. An academic group is a less formal organization than an academic department and each professor in the group has an appointment in an academic department. The Space Systems Academic Group has responsibility for the academic content of the Space Systems Operations and the Space Systems Engineering curricula. Instruction is carried out by faculty members attached to the following academic departments: Administrative Sciences, Aeronautics and Astronautics, Electrical and Computer Engineering, Mathematics, Meteorology, Oceanography, Operations Research and Physics. Thesis topics for students in this area of study are approved by the group and the final thesis is approved by the group Chairman in addition to the academic department granting the degree (if any).

GROUP FACILITIES

To provide laboratory experience several facilities have been developed in cooperation with other academic departments.

1) Solar Simulation Facility
2) Flash X-Ray Facility
3) Electron Linear Accelerator
4) Navigational Satellite Receiver Laboratory
5) Small Satellite Test and Development Laboratory
6) Vibro-Acoustic Test and Measurement Facility
7) FLTSATCOM Laboratory
8) Access to the Special Compartmented Information Facility for Classified Research and Theses Work.
9) Space Craft Testing Lab
10) S/C Attitude Dynamics and Control Lab

DEGREE REQUIREMENTS

The Space Systems Engineering students earn a master's degree in one of the following academic departments: Aeronautics and Astronautics, Computer Science, Electrical and Computer Engineering, Mechanical Engineering, Physics or Mathematics. Refer to degree requirements for the listed departments.

The Space Systems Operations students are awarded the degree Master of Science in Systems Technology (Space Systems Operations). A minimum of 45 quarter hours of graduate level work of which at least 15 hours must represent courses at the 4000 level. Graduate courses in at least four different academic disciplines must be included and in two disciplines, a course at the 4000 level must be included. There is also a requirement of three courses constituting advanced study in an area of specialization. Each student is required to write a thesis which is space oriented. The study program must be approved by the Chairman of the Space Systems Academic Group.

COURSE OFFERINGS

SS0810 THESIS RESEARCH (0-0).
Every student conducting thesis research enrolls in this course.

SS2001 INTRODUCTION TO SPACE (4-0).
An overview of space science, technology and policy with emphasis on topics of military interest. Topics usually included are: Space Environment, Orbital Mechanics, Directed

Energy Techniques, Space Power Systems, Guidance and Control, Communications, Propulsion and Launch Vehicles, Space Policy and Organization.

Upper Division or Graduate Courses

SS3001 MILITARY APPLICATIONS OF SPACE (4-0).
Examination of the military functions which utilize space systems and the capabilities of current systems, impact of space operations on military strategy, doctrine and tactics. National space policy and national organizations involved in space policy, DoD and service relationships. Tasking and use of space systems and ground support elements and techniques to reduce vulnerability. Impact of current R&D programs. Requires SECURITY clearance.

SS3035 MICROPROCESSORS FOR SPACE APPLICATIONS (3-2).
Same as MA3035, except for an additional hour deemed necessary to include space-oriented applications. An introduction to microprocessors at the hardware/software interface. Machine language programming, assembly language programming, connecting and controlling peripherals (terminal, disc drive...), operating systems.

SS3525 AIR/OCEAN REMOTE SENSING FOR INTERDISCIPLINARY CURRICULA (4-2).
Principles of radiative transfer and satellite sensors, and methods used to measure the atmosphere and ocean; visual, infrared and microwave radiometry and radar systems. Laboratory sessions illustrate lecture concepts using interactive displays of satellite data. Course designed for Space Operations, Space Systems Engineering, Anti-Submarine Warfare, Underwater Acoustics and other interdisciplinary curricula. PREREQUISITES: Undergraduate physics, and differential/integral calculus and ordinary differential equations; or consent of instructor.

SS3900 SPECIAL TOPICS IN SPACE SYSTEMS (Variable).
Directed study either experimental or theoretical in nature. PREREQUISITE: Consent of the Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

Graduate Courses

SS4000 SPACE SYSTEMS SEMINARS AND FIELD TRIPS (0-1).
Seminars consist of lectures to provide perspective on Space Systems. Field trips expose the student to various space activities such as industry, NASA and DoD laboratories and commands.

SS4001 DECISIONS AND SPACE SYSTEMS (4-0).
Cost-Performance Analysis including mission analysis, measures of performance and cost models. Study of the evolution of the interaction of technology, economics and politics in determining space-related activities. Discussion of the militarization of space. PREREQUISITES: SS3001, OS3008, MN3301, TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

SS4002 MILITARY OPERATIONS IN SPACE (4-0).
Operation of space systems to achieve mission objectives. Periods of vulnerability. Launch windows. Satellite defense: hardening, maneuver, encryption, covert spores, etc. ASAT operations, Launch windows. Weapons in space and threats to space systems. PREREQUISITES: SS4001, OS3603, TOP SECRET clearance with eligibility for SI/SAO. U.S. citizenship.

SS4900 ADVANCED STUDY IN SPACE SYSTEMS (Variable).
Directed graduate study based on journal literature, experimental projects or other sources. PREREQUISITE: Consent of the Chairman of Space Systems Academic Group and instructor. May be taken on Pass/Fail basis if the student has requested so at the time of enrollment.

DEFENSE RESOURCES MANAGEMENT INSTITUTE

Ralph W. West, Jr., Rear Admiral, U.S. Navy; Director (1989)*.

James S. Blandin, Professor (1974); Executive Director; PhD, University of Oregon, 1974

Donald E. Bonsper, Adjunct Professor (1982); MS, Naval Postgraduate School, 1970.

Robert E. Boynton, Associate Professor (1970); PhD, Stanford University, 1968.

Earl R. Brubaker, Professor (1983); PhD, University of Washington, 1964.

Mark C. Burns, LtCol, U.S. Army; Instructor (1991); MBA, Syracuse University, 1985.

Janie M. Chermak, Assistant Professor (1992); PhD, Colorado School of Mines, 1991.

Philip A. Costain, Adjunct Professor (1979); MS, Naval Postgraduate School, 1971.

Ralph Cundiff, Adjunct Research Professor (1992); BA, University of Pacific, 1977.

John E. Dawson, Professor (1966); PhD, Syracuse University, 1971.

Peter C. Frederiksen, Professor (1974); PhD, Washington State University, 1974.

Stephen F. Hurst, LtCol, U.S. Marine Corps; Instructor (1989); MS, Naval Postgraduate School, 1985.

Christopher M. Keller, Assistant Professor (1991); PhD, Indiana University, 1991.

John E. Keller, Adjunct Professor (1990); BA, Harvard University, 1956.

Charles J. LaCivita, Associate Professor (1985); PhD, University of California at Santa Barbara, 1981.

James K. Lowe, Maj, U.S. Air Force; Instructor (1991); PhD, Georgia Institute of Technology, 1984.

Francois Melese, Associate Professor (1987); PhD, University of Louvain, Belgium, 1982.

James H. Morris, Professor (1982); PhD, University of Oregon, 1976.

Robert T. Parrish, LCDR, U.S. Navy; Instructor (1990); MA, Boston University, 1989.

Neil E. Seiden, LCDR, U.S. Navy; Instructor (1991); MS, Naval Postgraduate School, 1991.

J.K. Stringer, Adjunct Professor (1991); MS, Naval Postgraduate School, 1973.

Larry E. Vaughan, Adjunct Professor (1992); MS, Naval Postgraduate School, 1974.

Robert von Pagenhardt, Professor (1967); PhD, Stanford University, 1970.

Kent D. Wall, Professor (1985); PhD, University of Minnesota, 1971.

Natalie J. Webb, Assistant Professor (1992); PhD, Duke University, 1992.

Darnell M. Whitt II, Associate Professor (1988); PhD, Johns Hopkins University, 1977.

* The year of joining the Naval Postgraduate School faculty is indicated in parentheses.

DEFENSE RESOURCES MANAGEMENT INSTITUTE
Established in 1965 as the Navy Management Systems Center and redesignated to its present title in May 1992, the Defense Resources Management Institute is a jointly staffed U.S. Department of Defense sponsored educational institution located as a tenant activity at the Naval Postgraduate School. It conducts educational programs in resources management, both in residence at Monterey and on-site, for military officers and civilian defense officials of the U.S. and cooperating foreign nations. The focus of all programs conducted by the center is on the development of knowledge and improvement of understanding of the concepts, techniques and application of modern defense management, with specific emphasis on analytical decision making. The mission, objectives and responsibilities of the center are set forth in Department of Defense Directive 5010.35.

The center currently offers the following resident courses within its facilities at the Naval Postgraduate School:

DEFENSE RESOURCES MANAGEMENT COURSE -
Four weeks in length; presented five times per year.

INTERNATIONAL DEFENSE MANAGEMENT COURSE -
Eleven weeks in length; presented twice a year.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE - Four weeks in length; presented once each year (normally in the month of June).
Descriptions of these courses are provided below; detailed information on current quota control agencies and procedures may be found in DoD Publication 5010.16-C (Defense Management Education and Training Catalog) or by calling DRMI at: Commercial (408) 656-2104, DSN 878-2104.

In addition to its regularly scheduled resident programs, the center also provides:

MOBILE EDUCATION COURSES - normally two or three weeks in length, for U.S. military services and defense agencies and for foreign governments upon specific request and approval.

COURSES FOR OTHER AGENCIES - programs are from two to four weeks duration, resident or on-site, for non-defense federal agencies and state and local governments, upon specific request and approval.

Faculty of the Institute are members of the faculty of the Naval Postgraduate School on assignment to the center.

Since 1966, over 18,000 officials, of whom more than 6,000 represented 98 foreign nations, have participated in programs conducted by the Institute.

DEFENSE RESOURCES MANAGEMENT COURSE
Military officers of all services, grades 0-4 and above, and civilian employees GS-11 and above, are eligible to attend this course. Also civilians in accelerated career development programs may attend.

The objective of this four-week course is to provide an appreciation of the concepts, principles and methods of defense management as they concern planning, programming, budgeting and related activities. Emphasis is placed on the analytical aspects of management, stemming from the disciplines of management systems, economics and quantitative analysis.

Participants are not expected to become experts or technicians in the various disciplines and subjects included in the curriculum. The objectives are to provide orientation on the overall functioning of the defense management process; insights as to what defense management requires in the way of inputs and analysis for decision making; understanding of the principles, methods and techniques used; and awareness of the interfaces between management requirements of the Defense Department components and

the Office of the Secretary of Defense. Course methodology includes lectures, small group discussions reinforced by illustrative case studies and problem sets, as well as selected daily reading assignments.

This course is primarily for U.S. officials, although limited numbers of international participants are normally also enrolled.

INTERNATIONAL DEFENSE MANAGEMENT COURSE
The course is designed for participants in the military grades of 0-4 (Major/Lieutenant Commander) through 0-6 (Colonel/Captain) and defense-related civilians of equivalent rank. Enrollment is currently limited to a maximum of 54 participants. Broad national representation is desired for this course, i.e., participation of at least 20-25 nations enhances the value of the comparative management aspects of this curriculum.

The course is presented in English.

The course provides a series of lectures in three major areas: the defense management environment, quantitative and economic analysis and management systems in the context of strategy, implementation and operations. The lectures are supplemented by small group discussions and workshops which concentrate on the lecture topics and associated readings, problems and cases. In the discussion groups, faculty members guide the interchange of ideas and are available to answer questions. Readings are assigned from within texts and supplemental material given to the participants to facilitate preparation for each lecture. Lecture outlines with additional suggested reading lists are provided. Occasional open seminar speakers are invited for special topics.

Throughout the course, the participants are encouraged to present and discuss information with respect to the defense management systems of their countries and to examine how the management concepts and techniques discussed by both the faculty and the participants from other countries may be applied in their own situations. Comparative study by means of interaction among participants is considered to be an extremely valuable characteristic of the course.

During the course, the center conducts a field trip to selected military and government agencies in the Washington, D.C. area. This trip provides an opportunity for the participants to receive special briefings on management techniques and problems and to observe actual practices at the operating level.

In the second half of the course, the general concepts of defense management are elaborated in detail during the examination of actual systems in financial, material and human resourses management. At the end of the course, a general review integrates the formal course material, special topics and field trip experiences.

SENIOR INTERNATIONAL DEFENSE MANAGEMENT COURSE
Enrollment is restricted to military flag and general officers (grades 0-7 and above) and defense-related civilians of equivalent rank, except that for countries where the 0-6 grade is comparable to flag/general rank, such officials may be enrolled on a waiver basis.

Participation in this course is normally from 50 to 54 senior officials from as many as 28 countries.

The course is presented in English.

The lecture, small discussion group, case study and problem format and content described above for IDMC also apply, but are compressed in time. Two or three guest speakers are invited to address the class and a short field trip is conducted.

TENTATIVE SCHEDULE OF RESIDENT COURSES
DEFENSE RESOURCES MANAGEMENT INSTITUTE
FISCAL YEAR 1993

COURSE NAME	COURSE NUMBER	LENGTH (weeks)	DATES (inclusive)
International Defense Management Course*	IDMC 92-2	11	28 SEP - 11 DEC 1992
Defense Resources Management Course	DRMC 93-1	4	04 JAN - 29 JAN 1993
International Defense Management Course	IDMC 93-1	11	08 FEB - 21 APR 1993
Defense Resources Management Course	DRMC 93-2	4	26 APR - 20 MAY 1993
Defense Resources Management Course	DRMC 93-3	4	24 MAY - 18 JUN 1993
24th Annual Senior Internationals Defense Management Course	SIDMC 93	4	28 JUN - 23 JUL 1993
Defense Resources Management Course	DRMC 93-4	4	26 JUL - 19 AUG 1993
Defense Resources Management Course	DRMC 93-5	4	23 AUG - 17 SEP 1993
International Defense Management Course*	IDMC 93-2	11	27 SEP - 10 DEC 1993

* These courses convene in one fiscal year and continue into the next fiscal year.

APPENDIX A: DISTINGUISHED ALUMNI

Among those U.S. officers who have completed a curricular program at the Naval Postgraduate School, the following officers (USN unless otherwise indicated) have attained flag rank and were on the active list as of June 1992:

Admiral Jerome L. Johnson
Admiral Robert J. Kelly

Vice Admiral Stanley R. Arthur
Vice Admiral Roger F. Bacon
Vice Admiral James F. Dorsey, Jr.
Vice Admiral William A. Dougherty, Jr.
Vice Admiral Peter M. Hekman, Jr.
Vice Admiral Robert K. U. Kihune
Vice Admiral Steven F. Loftus
Vice Admiral Henry H. Mauz, Jr.
Vice Admiral Joseph P. Reason
Vice Admiral James G. Reynolds
Vice Admiral Jerry O. Tuttle
Lieutenant General John J. Yeosock, USA

Rear Admiral Robert H. Ailes
Rear Admiral Richard C. Allen
Brigadier General John C. Arick, USMC
Rear Admiral Don W. Baird
Rear Admiral James B. Best
Rear Admiral Thomas C. Betterton
Rear Admiral David S. Bill III
Rear Admiral Larry E. Blose
Rear Admiral Michael W. Bordy
Rear Admiral William C. Bowes
Rear Admiral Steven R. Briggs
Rear Admiral Dennis M. Brooks
Rear Admiral Arlington F. Campbell
Rear Admiral Kenneth L. Carlsen
Rear Admiral Arthur K. Cebrowski
Rear Admiral Vernon E. Clark
Rear Admiral Philip J. Coady, Jr.
Rear Admiral Jon S. Coleman
Rear Admiral Michael C. Colley
Rear Admiral Dennis R. Conley
Rear Admiral Eugene D. Conner
Rear Admiral Michael T. Coyle
Rear Admiral Michael W. Cramer
Rear Admiral Walter J. Davis
Rear Admiral Joseph J. Dantone
Rear Admiral John J. Donegan, Jr.
Rear Admiral Philip F. Duffy
Rear Admiral William A. Earner
Rear Admiral Donald R. Eaton
Rear Admiral Lawrence G. Elberfeld
Rear Admiral Thomas R. M. Emery
Brigardier General George A. Fisher, USA
Rear Admiral James R. Fitzgerald
Rear Admiral Salvatore F. Gallo
Rear Admiral George N. Gee
Rear Admiral James B. Greene, Jr.
Rear Admiral Roland G. Guilbault
Rear Admiral William J. Hancock
Rear Admiral Robert G. Harrison
Rear Admiral Richard D. Herr, USCG
Rear Admiral Francis K. Holian
Rear Admiral Lowell J. Holloway
Rear Admiral John T. Hood
Rear Admiral R. B. Horne, Jr.
Rear Admiral Wesley E. Jordan, Jr.
Rear Admiral Douglas J. Katz
Rear Admiral James E. Koehr
Brigadier General Coleman D. Kuhn, USMC
Rear Admiral James A. Lair
Rear Admiral Bobby C. Lee
Rear Admiral Irve C. Lemoyne
Rear Admiral John A. Lockard
Rear Admiral Thomas J. Lopez
Rear Admiral Richard C. Macke
Rear Admiral Kenneth C. Malley
Rear Admiral Daniel P. March
Rear Admiral Thomas T. Matteson, USCG
Rear Admiral Henry C. McKinney
Rear Admiral Eric A. McVadon, Jr.
Rear Admiral Thomas A. Meinicke
Rear Admiral George R. Meinig, Jr.
Rear Admiral Thomas A. Mercer
Rear Admiral James E. Miller
Brigadier General Kenneth A. Minihan, USAF
Rear Admiral John T. Mitchell, Jr.
Rear Admiral Riley D. Mixson
Major General James M. Myatt, USMC
Rear Admiral Phillip R. Olson
Rear Admiral Paul W. Parcells
Rear Admiral Thomas D. Paulsen
Rear Admiral John D. Pearson
Rear Admiral James B. Perkins III
Rear Admiral Rudy K. Peschel, USCG
Rear Admiral Harry S. Quast
Rear Admiral David B. Robinson
Rear Admiral David N. Rogers
Rear Admiral Luther F. Schriefer
Rear Admiral Grant A. Sharp
Rear Admiral John F. Shaw
Brigadier General Stephen Silvasy, Jr., USA
Rear Admiral Robert J. Spane
Rear Admiral George R. Sterner
Brigadier General Joseph D. Stewart
Rear Admiral Thomas E. Stone
Rear Admiral George H. Strohsahl, Jr.
Rear Admiral Robert Sutton

Rear Admiral Jeremy D. Taylor
Rear Admiral William E. Terry
Rear Admiral Ralph L. Tindal
Rear Admiral William J. Tinston, Jr.
Rear Admiral Paul E. Tobin
Rear Admiral Robert L. Topping
Rear Admiral Robert E. Traister
Rear Admiral Jerry L. Unruh
Rear Admiral William L. Vincent
Rear Admiral Douglas Volgenau
Rear Admiral Joseph S. Walker
Rear Admiral Raymond M. Walsh
Rear Admiral Hugh L. Webster
Rear Admiral David E. White
Rear Admiral Ronald C. Wilgenbusch
Rear Admiral Richard A. Wilson
Rear Admiral Hugh D. Wisely
Rear Admiral Ray C. Witter
Rear Admiral Timothy W. Wright
Rear Admiral William H. Wright IV
Rear Admiral John J. Zerr

APPENDIX B: AWARDS FOR GRADUATES

ADMINISTRATIVE SCIENCES FACULTY AWARD FOR EXCELLENCE IN MANAGEMENT
Presented semiannually to an outstanding student in Administrative Sciences at the Naval Postgraduate School in recognition of distinguished academic achievement.

ADMIRAL WILLIAM ADGER MOFFETT AWARD
This award is presented annually to an outstanding graduate of the Aeronautical Engineering program on the basis of academic excellence, including thesis and career potential.

ARMED FORCES COMMUNICATIONS AND ELECTRONICS ASSOCIATION HONOR AWARD
Presented to that officer graduate who has achieved academic excellence and best demonstrated professional qualities in one of the following programs: Electronics, Communications, Intelligence, Command and Control, or Computer Technology.

ARMY CHIEF OF STAFF AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH
Presented semiannually to a U.S. Army Officer student in the Operations Analysis program who possesses an outstanding academic record, including thesis and project work, and who demonstrates qualities indicative of an outstanding military officer.

ASTRONAUT MICHAEL J. SMITH, CAPT, USN, ASTRONAUTICS AWARD
Astronaut and CAPT Michael J. Smith, who was an alumnus of NPS, gave his life exploring space for the enrichment of mankind. This award is presented annually to an outstanding graduate of the Space Systems Engineering or Space Systems Operations curricula. The award is made on the basis of the student's academic excellence, including thesis, and his career potential.

CAPTAIN JOHN C. WOELFEL AWARD
Presented each June to the outstanding Naval Engineering program officer student on the basis of academic and leadership qualities and performance. Officers from the past September, December, March and June graduation classes are considered.

CHIEF OF NAVAL OPERATIONS ANTISUBMARINE WARFARE AWARD
Sponsored by the National Security Industrial Association and presented in recognition of distinguished academic achievement to that Antisubmarine Warfare curriculum graduate who has demonstrated outstanding academic performance and exhibited those qualities indicative of an outstanding military officer.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN MANPOWER, PERSONNEL AND TRAINING ANALYSIS
This award is given semiannually to U.S. Navy, or Op-01 sponsored civilian, graduate of the Manpower, Personnel and Training Analysis curriculum who has demonstrated outstanding academic performance, thesis quality and leadership potential.

CHIEF OF NAVAL OPERATIONS AWARD FOR EXCELLENCE IN OPERATIONS RESEARCH
Presented semiannually to the outstanding USN or USMC graduate of the Operations Research program on the basis of academic achievement, experience tour performance, thesis work and demonstration of those qualities indicative of the outstanding military officer.

CHIEF OF NAVAL OPERATIONS COMMUNICATIONS AWARD
Presented in recognition of distinguished academic achievement in the Communications Engineering or Telecommunications Systems programs to that graduate who has attained an outstanding academic record and who exhibits those qualities of an outstanding military officer.

CONRAD SCHOLAR AWARD FOR DISTINGUISHED ACADEMIC ACHIEVMENT IN FINANCIAL MANAGEMENT.
Presented semiannually to an outstanding Unrestricted Line (URL) officer in the Financial Management community who has demostrated academic excellence, presented a finanical management essay for publication, and exhibited the potential for outstanding leadership while attending the Navel Postgraduate School.

DEPARTMENT OF THE NAVY AWARD FOR ACADEMIC EXCELLENCE IN FINANCIAL MANAGEMENT
This award is presented semiannually to a financial management student who demonstrates overall academic performance, academic excellence in financial management courses, high leadership potential, future ability to contribute to professional, academic and public forums while meeting the highest standards of stewardship of the national trust, and thesis excellence.

JOINT CHIEFS OF STAFF COMMAND, CONTROL AND COMMUNICATIONS AWARD
Presented to the outstanding graduate of the Command, Control and Communications program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

MEWBORN STUDENT RESEARCH AWARD
Presented annually to an officer student whose thesis exhibits sound scholarship and highest research ability. Criteria of selection conform as nearly as possible to the concept of "evidence of research potential" which forms the basis for election to Associate Membership in the Society of Sigma Xi.

MILITARY OPERATIONS RESEARCH SOCIETY GRADUATE RESEARCH AWARD
Presented in recognition of outstanding achievement in graduate research directed toward improving military force utilization. The primary award criterion is research which leads to demonstration of, or potential for, increased operating effectiveness of currently available or near term assets.

MONTEREY KIWANIS CLUB OUTSTANDING FOREIGN STUDENT AWARD
Presented annually, this award is based on criteria provided by the Kiwanis Club of Monterey including the following; academic standing and achievements, involvement in community affairs, motivation, demeanor and appearance, and relationship with other students.

MONTEREY PENINSULA COUNCIL NAVY LEAGUE AWARD FOR HIGHEST ACADEMIC ACHIEVEMENT
The award is presented quarterly to the graduation USN, USMC, USCG or NOAA student who has maintained an outstanding overall academic record at the Naval Postgraduate School. Excellent academic achievement, thesis research, military bearing, motivation and community involvement are the criteria for selection.

THE NAVAL POSTGRADUATE SCHOOL SUPERIOR SERVICE AWARD
This award is presented intermittently for outstanding service which would have a lasting impact on the student community and the school. The award is based on leadership, organizational abilities and the nominee should have in some way improved the life of students and the community.

NAVAL SEA SYSTEMS COMMAND AWARD FOR EXCELLENCE IN UNDERSEA WARFARE TECHNOLOGY
This award is presented annually at the March graduation ceremony to an outstanding officer student who successfully completes any curricular program and a thesis which demonstrates outstanding potential for application to Underseas Warfare Technology.

NAVAL SEA SYSTEMS COMMAND AWARD FOR COMBAT SYSTEMS EXCELLENCE
Presented in recognition of distinguished scholastic achievement in a Combat Systems related field of study. Selection is based upon marks attained, quality and applicability of thesis, and demonstrated leadership potential in the field of Weapons Engineering.

NAVAL SEA SYSTEMS COMMAND AWARD IN ELECTRONIC WARFARE TECHNOLOGY
Presented in recognition of academic achievement in the Electronic Warfare Systems Technology program to that graduate who has attained an outstanding academic record and who has exhibited outstanding leadership qualities.

NAVAL SEA SYSTEMS COMMAND AWARD IN NAVAL ENGINEERING
Presented in recognition of distinguished academic achievement in the Naval Engineering Program. The criteria for the award include: demonstrated academic excellence measured by marks attained, content of thesis and demonstrated leadership potential in Naval Engineering.

NAVAL SUPPLY SYSTEMS COMMAND AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES
Presented semiannually to an outstanding U.S. Navy Supply Corps officer in Administrative Sciences. This award is made on the basis of academic achievement, research excellence, contribution to the professional and civilian community, and faculty recommendation.

NAVAL SURFACE WEAPONS CENTER AWARD FOR EXCELLENCE IN SURFACE WARFARE TECHNOLOGY
Presented semiannually to a U.S. Naval officer of high academic standing whose thesis topic and quality of supporting research demonstrates the greatest potential for contribution to surface warfare.

NAVAL UNDERWATER SYSTEMS CENTER AWARD FOR EXCELLENCE IN UNDERWATER SYSTEMS TECHNOLOGY
Presented annually to the student, who by academic standing and relevance of thesis topic, has demonstrated the greatest achievement in the field of Underwater Systems Technology.

OCEANOGRAPHER OF THE NAVY AIR-OCEAN SCIENCES AWARD
Presented to a U.S. Naval Officer graduate of the Air-Ocean Sciences program who has demonstrated outstanding performance and exhibited those qualities indicative of an outstanding military officer.

THE OUTSTANDING ACADEMIC ACHIEVEMENT AWARD FOR DEPARTMENT OF DEFENSE STUDENTS
Presented quarterly to the graduating USA, USAF or DoD civilian student who has maintained an outstanding academic record at the Naval Postgraduate School based on the same criteria as the Navy League Award.

THE OUTSTANDING ACADEMIC ACHIEVEMENT AWARD FOR INTERNATIONAL STUDENTS
This award is presented quarterly on the basis of outstanding achievement in the areas of academic achievement, thesis research, military bearing, motivation, community involvement and relationship with other students.

REAR ADMIRAL GRACE MURRAY HOPPER AWARD FOR COMPUTER TECHNOLOGY
Presented to a graduating USN, USMC or USCG officer on the basis of thesis quality, academic performance and demonstrated leadership ability in the study of computer technology.

REAR ADMIRAL THOMAS R. MCCLELLAN AWARD FOR ACADEMIC EXCELLENCE IN ADMINISTRATIVE SCIENCES
Presented to a graduate of Administrative Sciences from the aviation community, based upon academic performance, professional commitment and leadership potential.

SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONICS SYSTEMS ENGINEERING
Presented semiannually to a U.S. Naval Officer Student in recognition of distinguished academic achievement in the advanced Electronics Engineering program.

THE SPACE AND NAVAL WARFARE SYSTEMS COMMAND AWARD IN ELECTRONIC WARFARE TECHNOLOGY
Presented in September to the Naval Postgraduate School student graduating in the Electronic Warfare Systems Technology curriculum who possesses an outstanding academic record, including thesis work, and exhibits outstanding leadership qualities.

THE SPACE SYSTEMS ENGINEERING AWARD FOR ACADEMIC EXCELLENCE
Presented annually to an outstanding student in Space Systems Engineering program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

THE SPACE SYSTEMS OPERATIONS AWARD FOR ACADEMIC EXCELLENCE
Presented annually to an outstanding student in the Space Systems Operations program in recognition of distinguished academic achievement based upon grades obtained, quality of thesis and overall performance.

APPENDIX C: AWARDS FOR FACULTY

WARREN RANDOLPH CHURCH AWARD
Presented annually to an officer student for outstanding performance in mathematics. The criteria for selection include evidence of initiative, scholarly attitude and mathematical maturity.

THE CARL E. AND JESSE W. MENNEKEN ANNUAL FACULTY AWARD FOR EXCELLENCE IN SCIENTIFIC RESEARCH
Mrs. Jesse W. Menneken has provided the NPS Foundation with an annual award of $2000.00 to be presented to an NPS faculty member who has exhibited outstanding research efforts in science or engineering. Presented annually at the December graduation if suitable candidates are nominated.

CARL E. MENNEKEN RESEARCH AWARD
Awarded at the Spring initiation meeting of Sigma Xi and acknowledged at the June commencement exercises, this award is based on distinguished research contributions.

DISTINGUISHED PROFESSOR AWARD
Presented to a faculty member who has merited recognition for his or her scholarly accomplishments and lasting educational contributions to the school. The recipient of this award joins a select group of faculty bearing the title of Distinguished Professor.

REAR ADMIRAL JOHN JAY SCHIEFFELIN AWARD FOR EXCELLENCE IN TEACHING
This award is made annually to recognize faculty members, who, through wide consensus, excel as teachers. This consensus is ascertained through a ballot polling of students and graduates.

INDEX

Academic Calendar 317-318
Academic Counseling 22-23
Academic Departments and Groups
Description, listing 12-17
Administrative Sciences Department 146
Faculty 146-149
Master of Science in Information Systems Requirements 149-150
Master of Science in Management Requirements 150
Master of Science in Telecommunications Systems 150
Management Requirements 150
Course Offerings 151-162
Aeronautics and Astronautics Department 163
Faculty 163-164
Master of Science in Aeronautical Engineering Requirements 164-165
Master of Science in Engineering Science Requirements 165
Master of Science in Astronautical Engineering (Curriculum 591) Requirements 165-166
Aeronautical and Astronautical Engineer Requirements 166
Doctor of Philosophy in Aeronautical Engineering Requirements 166
Doctor of Engineering in Aeronautical Engineering Requirements 166
Aeronautical Laboratories 166-168
Navy-NASA Joint Institute of Aeronautics 168
Space Systems Laboratories 168
Course Offerings 168-176
Antisubmarine Warfare Academic Group 177
Faculty 177
Master of Science in Applied Science Requirements 177
Course Offerings 178
Aviation Safety Programs 179
Faculty 179
Aviation Safety Officer Course 179-180
Aviation Safety Command Course 180
Course Offerings 180-181
Command, Control and Communications (C3)
Academic Group 182
Faculty 182
Master of Science in Systems Technology Requirements 183
Course Offerings 183-184
Computer Science Department 185
Faculty 185-186
Master of Science in Computer Science Requirements 186
Doctor of Philosophy in Computer Science Requirements 186
Computer Science Laboratories 186-188
Course Offerings 188-195
Electrical and Computer Engineering Department 196
Faculty 196-197
Master of Science in Electrical Engineering Requirements 198
Master of Science in Engineering Science Requirements 198-199
Electrical Engineer Requirements 199
Doctor of Philosophy in Electrical and Computer Engineering Requirements 199
Electrical and Computer Engineering Laboratories 199-200
Course Offerings 200-213

Electronic Warfare Academic Group 214
Faculty 214
Master of Science in Systems Engineering Requirements 214
Course Offerings 214
Engineering Acoustics Academic Committee 215
Master of Science in Engineering Acoustics Requirements 215
Doctor of Philosophy in Engineering Acoustics Requirements 215
Doctor of Engineering in Engineering Acoustics Requirments 215
Mathematics Department 216
Faculty 216-217
Master of Science in Applied Mathematics Requirements 217
Course Offerings 218-226
Mechanical Engineering Department 227
Faculty 227-228
Master of Science in Mechanical Engineering Requirements 228
Master of Science in Engineering Science Requirements 228-229
Mechanical Engineer Requirements 229
Doctor of Philosophy in Mechanical Engineering Requirements 229
Doctor of Engineering in Mechanical Engineering Requirements 229-230
Mechanical Engineering Laboratories 230
Course Offerings 238
Meteorology Department 239
Faculty 239-240
Master of Science in Meteorology Requirements 240
Master of Science in Meteorology and Physical Oceanography Requirements 240-241
Doctor of Philosophy in Meteorology Requirements 241
Meteorology Laboratories 241-242
Course Offerings 242-247
National Security Affairs Department 248
Faculty 248-249
Master of Arts in National Security Affairs Requirements 250
Master of Science in National Security Affairs Requirements 250
Course Offerings 251-260
Oceanography Department 261
Faculty 261-262
Master of Science in Physical Oceanography Requirements 262-263
Master of Science in Hydrographic Sciences Requirements 263
Master of Science in Meteorology and Physical Oceanography Requirements 263
Doctor of Philosophy in Oceanography Requirements 263
Oceanographic Laboratories 263-264
Course Offerings 264-268
Operations Research Department 269
Faculty 269-271
Master of Science in Applied Science Requirements 271
Master of Science in Operations Research Requirements 271-272
Course Offerings 272-283
Physics Department 284
Faculty 284-285
Master of Science in Physics Requirements 285-286
Master of Science in Engineering Science Requirements 286

Doctor of Philosophy in Physics Requirements 286-287
Physics Laboratories 287
Course Offerings 287-298
Space Systems Academic Group 299
Group Facilities 299
Course Offerings 299-300
Academic Profile Codes 19-20
Accreditation 7
Administration 12
Administrative Sciences Department 146-162
Administrative Sciences Programs 26-52
Administrative Staff 12
Aeronautical and Astronautical Engineer Requirements 163-176
Aeronautical Engineering Programs 53-60
Aeronautical Laboratories 166-168
Aeronautics and Astronautics Department 163-176
Air-Ocean Programs 61-70
Antisubmarine and Electronic Warfare Programs 71-77
Antisubmarine Warfare Academic Group 177-178
Aviation Safety Programs 179-181
Aviation Safety Command Course 180
Aviation Safety Officer Course 179
Awards for Graduates 306-309
Awards for Faculty 310
Board of Advisors 11
Catalogs, Ordering Information ..... Inside Cover
Chief of Naval Operations Statement 6
Civilian Universities 25
Combat Systems Sciences and Technology Program
Command, Control and Communications (C3)
Academic Group 182-184
Computer Science Department 185-195
Computer Science Laboratories 186-188
Computer Technology Programs 83-91
Course Codes 21
Course Overload 23
Course Registration and Credit 23
Overload
Repetition of Courses 23
Medical Absence 23
Credit by Examination 23
Curriculum 360, Operations Analysis 135-136
Curriculum 361, Operational Logistics 136-138
Curriculum 365, Joint Command, Control
and Communications (C3) 95-96
Curriculum 366, Space Systems Operations 96-98
Curriculum 368, Computer Science 83-85
Curriculum 372, Meteorology 61
Curriculum 373, Air-Ocean Sciences 62-64
Curriculum 374, Operational Oceanography 64-65
Curriculum 380, Advanced Science (Applied Mathematics) 138-140
Curriculum 440, Oceanography 66-68
Curriculum 525, Antisubmarine Warfare 71-72
Curriculum 533, Combat Systems Sciences And Technology 78-80
Curriculum 570, Naval Engineering Programs 129-132
Curriculum 590, Electronic Systems Engineering 92-93
Curriculum 591, Space Systems Engineering 98-100
Curriculum 595, Electronic Warfare 72-74
Curriculum 596, Electronic Warfare (International) 74-75

Curricula 610 and 611, Aeronautical Engineering and Aeronautical Engineering with Avionics 53-56
Curricula 681 - 684, Area Studies 107-111
Curriculum 688, Strategic Planning and International Organizations and Negotiations 111-113
Curriculum 699, Special Operations/Low Intensity 113-114
Curriculum 813, Transportation Logistics Management 26-27
Curriculum 814, Transportation Management 27-29
Curriculum 815, Acquisition and Contract Management 29-31
Curriculum 817, Administrative Services (NON USN) 33-38
Curriculum 819, Systems Inventory Management 38-40
Curriculum 825, Intelligence 114-118
Curriculum 827, Material Logistics Support Management 40-42
Curriculum 837, Financial Management 42-43
Curriculum 847, Manpower, Personnel and Training Analysis Avionics 44-45
Curricular Offices
- Description, listing 13
- Administrative Sciences Programs 26
  - Transportation Logistics Management, Curriculum 813 26-27
  - Transportation Management, Curriculum 814 27-29
  - Acquisition and Contract Management, Curriculum 815 29-31
  - Systems Acquisition Management 31-33
  - Administrative Services (NON USN), Curriculum 817 33-38
  - Systems Inventory Management, Curriculum 819 38-40
  - Material Logistics Support Management, Curriculum 827 40-42
  - Financial Management, Curriculum 837 42-43
  - Manpower, Personnel and Training Analysis, Curriculum 847 44-45
- Aeronautical Engineering Programs 53-60
  - Aeronautical Engineering and Aeronautical Engineering with Avionics, Curricula 610 and 611 53-56
- Air-Ocean Sciences Programs 61-70
  - Meteorology, Curriculum 372 61
  - Air-Ocean Sciences, Curriculum 373 62-64
  - Operational Oceanography, Curriculum 374 64-65
  - Oceanography, Curriculum 440 66-68
- Antisubmarine Warfare/Electronic Warfare Programs 71-77
  - Antisubmarine Warfare, Curriculum 525 71-72
  - Electronic Warfare, Curriculum 595 72-74
  - Electronic Warfare (International), Curriculum 596 74-75
- Computer Technology Programs 83-91
  - Computer Science, Curriculum 368 83-85
- Electronic and Communications Programs 92-94
  - Electronic Systems Engineering, Curriculum 590 92-93
- Space Systems Programs 95-106
  - Joint Command, Control and Communications (C3), Curriculum 365 95-96
  - Space Systems Operations, Curriculum 366 96-98
  - Space Systems Engineering, Curriculum 591 98-100
- National Security Affairs and Intelligence Programs 107-128
  - Area Studies, Curricula 681 - 684 107-111
  - Strategic Planning and International Organizations and Negotiations, Curriculum 688 111-113
  - Intelligence, Curriculum 825 114-118
- Naval Engineering Programs 129-134
  - Naval Engineering Programs, Curriculum 570 129-132
- Operations Analysis Programs 135-145
  - Operations Analysis, Curriculum 360 135-136

Operational Logistics, Curriculum 361 136-138
Advanced Science (Applied Mathematics), Curriculum 380 138-140
Defense Resources Management Institute 301-304
Faculty 301
Defense Resources Management Course 302-303
International Defense Management Course 303
Senior International Defense Management Course 303
Tentative Schedule of Resident Courses 304
Degree Programs, Civilian Students 19
Degrees Conferred 7
Dual Degree Programs 24
Distinguished Alumni 305
Doctor of Engineering in Aeronautical Engineering
Requirements 166
Doctor of Engineering in Engineering Acoustics
Requirements 215
Doctor of Engineering in Mechanical Engineering
Requirements 229
Doctor of Philosophy in Aeronautical Engineering
Requirements 166
Doctor of Philosophy in Computer Science Requirements 186
Doctor of Philosophy in Electrical and Computer Engineering
Requirements 199
Doctor of Philosophy in Engineering Acoustics
Requirements 215
Doctor of Philosophy in Mechanical Engineering
Requirements 229
Doctor of Philosophy in Meteorology Requirements 241
Doctor of Philosophy in Oceanography Requirements 263
Doctor of Philosophy in Physics Requirements 286
Doctor of Philosophy in Operations Research 272
Electrical and Computer Engineering Department 196-213
Electrical and Computer Engineering Laboratories 199
Electrical Engineer Requirement 199
Electronics and Communications Programs 196
Electronic Warfare Academic Group 214
Engineering Acoustics Academic Committee 215
Faculty Organizations 17
Grading 22
Graduate Education Review Board 11
Joint Command, Control and Communications (C3) and
Space Systems Programs 95
Map ..... Inside Back Cover
Master of Arts in National Security Affairs Requirements 250
Master of Science in Aeronautical Engineering
Requirements 164
Master of Science in Applied Mathematics Requirements 217
Master of Science in Applied Science Requirements 177
Master of Science in Astronautical Engineering
(Curriculum 591) Requirements 165
Master of Science in Computer Science Requirements 186
Master of Science in Electrical Engineering Requirements 198
Master of Science in Engineering Science
Requirements 215
Master of Science in Information Systems Requirements 150
Master of Science in Management Requirements 150
Master of Science in Mechanical Engineering
Requirements 228
Master of Science in Meteorology Requirements 240

Master of Science in Meteorology and Physical Oceanography Requirements 240-241
Master of Science in National Security Affairs Requirements 250
Master of Science in Operations Research Requirements 271-272
Master of Science in Physical Oceanography Requirements 262-263
Master of Science in Physics Requirements 285-286
Master of Science in Systems Engineering Requirements 214
Master of Science in Systems Technology Requirements 183
Master of Science in Telecommunications Systems Management Requirements 150
Mathematics Department 216-226
Mechanical Engineer Requirements 228-229
Mechanical Engineering Department 227-238
Mechanical Engineering Laboratories 230
Medical Absence 23
Meteorology Department 239-247
Meteorology Laboratories 241-242
The Mission 7
Quality Point Rating, (QPR) 22
National Security Affairs Department 248-260
National Security and Intelligence Programs 107-128
Naval Engineering Programs 129-134
Naval Postgraduate School, Introduction 6
Navy-NASA Joint Institute of Aeronautics 168
Non-Degree Programs, Civilian Students 19
Oceanographic Laboratories 263
Operations Analysis Programs 135-145
Oceanography Department 261-268
Operations Research Department 269-283
Physics Department 284-298
Physics Laboratories 287
Regular Curricular, Civilian Students 19
Repetition of Courses 23
The School 7
Selection Procedures 18
- Naval Officers 18
- Other U.S. Military 18
- Allied Country Military Officers 18
- Civilian Employees of U.S. Government 18
  - Regular Curricular 19
  - Degree Programs 19
  - Non-Degree Programs 19
  - Admission 19

Space Systems Operations Academic Group 299-300
Student Council 17
Transfer of Credits 23-24
Validation 23

ACADEMIC CALENDAR AY 1993

FALL QUARTER

Reporting Date	Monday, September 21, 1992
Instruction Begins	Monday, September 28, 1992
Columbus Day (Holiday)	Monday, October 12, 1992
Reporting Day for Refresher	Monday, November 2, 1992
Refresher Begins	Monday, November 9, 1992
Veteran's Day (Holiday)	Wednesday, November 11, 1992
Thanksgiving Day (Holiday)	Thursday, November 26, 1992
Final Examinations Begin	Monday, December 14, 1992
Graduation	Thursday, December 17, 1992
Christmas Break	Dec. 18, 1992 - Jan. 3, 1993

WINTER QUARTER

Reporting Date	Monday, December 28, 1992
New Year's Day (Holiday)	Friday, January 1, 1993
Instruction Begins	Tuesday January 5, 1993
Martin Luther King's Birthday (Holiday)	Monday, January 18, 1993
Reporting Date for Refresher	Monday, February 8, 1993
Washington's Birthday (Holiday)	Monday, February 15, 1993
Refresher Begins	Tuesday, February 16, 1993
Final Examinations Begin	Monday, March 22, 1993
Graduation	Thursday, March 25, 1993

SPRING QUARTER

Reporting Date	Monday, March 22, 1993
Instruction Begins	Monday, March 29, 1993
Reporting Date for Refresher	Monday, May 3, 1993
Refresher Begins	Monday, May 10, 1993
Memorial Day (Holiday)	Monday, May 31, 1993
Final Examinations Begin	Monday, June 14, 1993
Graduation	Thursday, June 17, 1993
Summer Break	June 18 - July 4, 1993

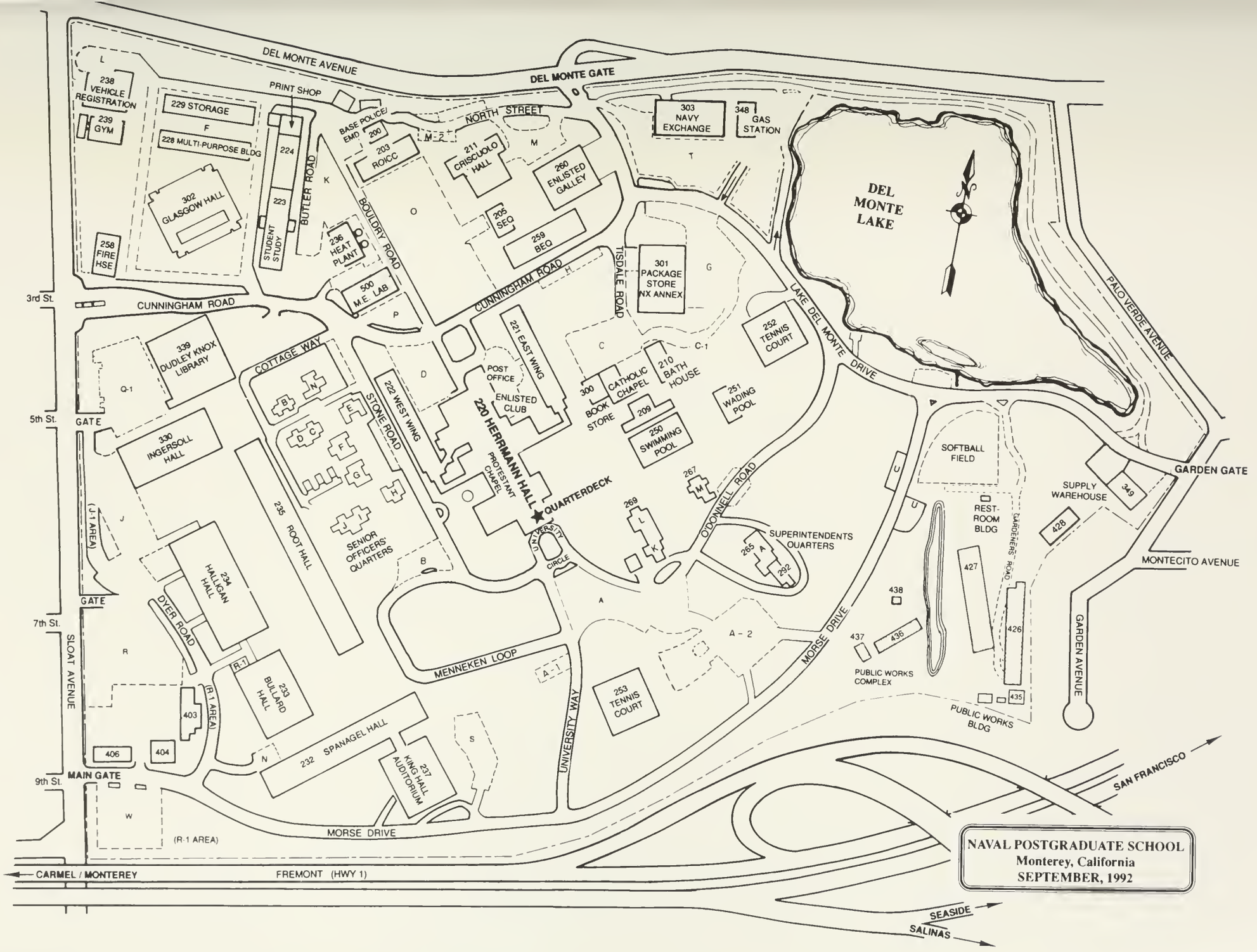
SUMMER QUARTER

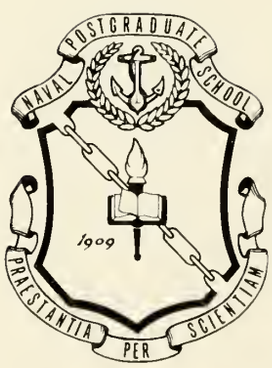
Reporting Date	Monday, June 28, 1993
Independence Day (Holiday)	Thursday, July 5, 1993
Instruction Begins	Monday, July 6, 1993
Reporting Date for Refresher	Monday, August 6, 1993
Refresher Begins	Monday, August 16, 1993
Labor Day (Holiday)	Monday, September 6, 1993
Final Examinations Begin	Monday, September 20, 1993
Graduation	Thursday, September 23, 1993

ACADEMIC CALENDAR AY 1994

FALL QUARTER	
Reporting Date	Monday September 20, 1993
Instruction Begins	Monday September 27, 1993
Columbus Day (Holiday)	Monday October 11, 1993
Reporting Date for Refresher	Monday November 1, 1993
Refresher Begins	Monday November 8, 1993
Veteran's Day (Holiday)	Thursday November 11, 1993
Thanksgiving Day (Holiday)	Thursday November 25, 1993
Final Examination Begin	Monday December 13, 1993
Graduation	Thursday December 16, 1993
Christmas Break	17 Dec - 2 Jan 1994
WINTER QUARTER	
Reporting Date	Monday December 27, 1993
New Year's Day (Holiday)	Friday December 31, 1993
Instruction Begins	Monday January 3, 1994
Martin Luther King's Birthday (Holiday)	Monday January 17, 1994
Reporting Date for Refresher	Monday February 7, 1994
Refresher Begins	Monday February 14, 1994
George Washington's Birthday (Holiday)	Monday February 21, 1994
Final Examinations Begin	Monday March 21, 1994
Graduation	Thursday March 24, 1994
SPRING QUARTER	
Reporting Date	Monday March 21, 1994
Instruction Begins	Monday March 28, 1994
Reporting Date for Refresher	Monday May 2, 1994
Refresher Begins	Monday May 9, 1994
Memorial Day (Holiday)	Monday May 30, 1994
Final Examination Begin	Monday June 13, 1994
Graduation	Thursday June 16, 1994
Summer Break	17 Jun. - 3 Jul. 1994
SUMMAR QUARTER	
Reporting Date	Monday June 27, 1994
Independence Day (Holiday)	Monday July 4, 1994
Instruction Begins	Tuesday July 5, 1994
Reporting Date for Refresher	Monday August 8, 1994
Refresher Begins	Monday August 15, 1994
Labor Day (Holiday)	Monday September 5, 1994
Final Examinations Begin	Monday September 19, 1994
Graduation	Thursday September 22, 1994

U.S. GOVERNMENT PRINTING OFFICE: 1993-784-794


DEL MONTE AVENUE
DEL MONTE GATE
PRINT SHOP
238 VEHICLE REGISTRATION
239 GYM
229 STORAGE
228 MULTI-PURPOSE BLDG
302 GLASGOW HALL
258 FIRE HSE
224
223
STUDENT STUDY
BUTLER ROAD
BASE POLICE/ EMD
200
203 ROICC
NORTH STREET
211 CRISCUOLO HALL
260 ENLISTED GALLEY
205 SEQ
259 BEQ
236 HEAT PLANT
BOULDRY ROAD
500 M.E. LAB
303 NAVY EXCHANGE
348 GAS STATION
DEL MONTE LAKE
PALO VERDE AVENUE
3rd St.
CUNNINGHAM ROAD
CUNNINGHAM ROAD
TISDALE ROAD
301 PACKAGE STORE NX ANNEX
252 TENNIS COURT
LAKE DEL MONTE DRIVE
339 DUDLEY KNOX LIBRARY
COTTAGE WAY
221 EAST WING
POST OFFICE
ENLISTED CLUB
300 BOOK STORE
CATHOLIC CHAPEL
210 BATH HOUSE
251 WADING POOL
209
250 SWIMMING POOL
222 WEST WING
STONE ROAD
220 HERRMANN HALL
PROTESTANT CHAPEL
QUARTERDECK
5th St.
GATE
330 INGERSOLL HALL
SOFTBALL FIELD
GARDEN GATE
SUPPLY WAREHOUSE
349
428
REST-ROOM BLDG
GARDENERS ROAD
MONTECITO AVENUE
O'DONNELL ROAD
267
269
SUPERINTENDENTS QUARTERS
265
292
UNIVERSITY CIRCLE
SENIOR OFFICERS' QUARTERS
235 ROOT HALL
(J-1 AREA)
GATE
234 HALLIGAN HALL
DYER ROAD
7th St.
SLOAT AVENUE
MENNEKEN LOOP
233 BULLARD HALL
(R-1 AREA)
403
404
406
232 SPANAGEL HALL
237 KING HALL AUDITORIUM
253 TENNIS COURT
UNIVERSITY WAY
MORSE DRIVE
438
437
436
427
426
435
PUBLIC WORKS COMPLEX
PUBLIC WORKS BLDG
GARDEN AVENUE
9th St.
MAIN GATE
MORSE DRIVE
(R-1 AREA)
SAN FRANCISCO
CARMEL / MONTEREY
FREMONT (HWY 1)
SEASIDE
SALINAS
NAVAL POSTGRADUATE SCHOOL
Monterey, California
SEPTEMBER, 1992



NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943-5000
408-656-3093 • DSN 878-3093